

TEST REPORT

FCC SAR Part 2 Test for SM-A276B/DS
Certification

APPLICANT
SAMSUNG Electronics Co., Ltd.

REPORT NO.
HCT-SR-2604-FC006

DATE OF ISSUE
April 27, 2026

Tested by
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TEST REPORT

PART 2 RF Exposure
Compliance Test
for certification

REPORT NO.

HCT-SR-2604-FC006

DATE OF ISSUE

April 27, 2026

FCC ID

A3LSMA276B

Applicant

SAMSUNG Electronics Co., Ltd
129, Samsung-ro, Yeongtong-gu, Suwon-Si, Gyeonggi-do, 16677, Korea

Product Name

Mobile Phone

Model Name

SM-A276B/DS

Additional Model Name

SM-A276B

Date of Test

April 13, 2026~ April 17, 2026

Location of Test

☒ Permanent Testing Lab ☐ On Site Testing Lab
(Address: 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea)

FCC Rule Part(s)

CFR § 2.1093

Results

Pass

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	April 27, 2026	Initial Release

Notice

Content

The results shown in this test report only apply to the sample(s), as received, provided by the applicant, unless otherwise stated.

The test results have only been applied with the test methods required by the standard(s).

The laboratory is not accredited for the test results marked *.

Information provided by the applicant is marked **.

Test results provided by external providers are marked ***.

When confirmation of authenticity of this test report is required, please contact www.hct.co.kr

The test results in this test report are not associated with the ((KS Q) ISO/IEC 17025) accreditation by KOLAS (Korea Laboratory Accreditation Scheme) / A2LA (American Association for Laboratory Accreditation) that are under the ILAC (International Laboratory Accreditation Cooperation) Mutual Recognition Agreement (MRA).

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1. RF Exposure Limits

1.1 RF Exposure Limits for Frequencies < 6 GHz

HUMAN EXPOSURE	UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT Occupational (W/kg) or (mW/g)
SPATIAL PEAK SAR * (Partial Body)	1.6	8.0
SPATIAL AVERAGE SAR ** (Whole Body)	0.08	0.4
SPATIAL PEAK SAR *** (Hands / Feet / Ankle / Wrist)	4.0	20.0

NOTES:

* The Spatial Peak value of the SAR averaged over any 1 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

** The Spatial Average value of the SAR averaged over the whole-body.

*** The Spatial Peak value of the SAR averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

1.2 Interim Guidance for Time Averaging

Per October 2018 TCB Workshop Notes, the below time-averaging windows can be used for assessing time-averaged exposures for devices that are capable of actively monitoring and adjusting power output over time to comply with exposure limits.

Interim Guidance	Frequency (GHz)	Maximum Averaging Time (sec)
SAR	< 3	100
	3 – 6	60
MPE	6 - 10	30
	10 - 16	14
	16 – 24	8
	24 – 42	4
	42 – 95	2

2. Test Location

2.1 Test Laboratory

Company Name	HCT Co., Ltd.
Address	74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Republic of Korea
Telephone	031-645-6300
Fax.	031-645-6401

2.2 Test Facilities

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

Korea	National Radio Research Agency (Designation No. KR0032)
	KOLAS (Testing No. KT197)

2.3 General Information of the EUT

Model Name	SM-A276B/DS
Additional Model Name	SM-A276B
Equipment Type	Mobile Phone
FCC ID	A3LSMA276B
Application Type	Certification
Applicant	SAMSUNG Electronics Co., Ltd.

3. DEVICE UNDER TEST DESCRIPTION

3.1 DUT specification

Device Wireless specification overview		
Band & Mode	Operating Mode	Tx Frequency
GSM850	Voice / Data	824.2 MHz ~ 848.8 MHz
GSM1900	Voice / Data	1 850.2 MHz ~ 1 909.8 MHz
UMTS Band 2	Voice / Data	1 852.4 MHz ~ 1 907.6 MHz
UMTS Band 4	Voice / Data	1 712.4 MHz ~ 1 752.6 MHz
UMTS Band 5	Voice / Data	826.4 MHz ~ 846.6 MHz
LTE FDD Band 2 (PCS)	Voice / Data	1 850.7 MHz ~ 1 909.3 MHz
LTE FDD Band 4 (AWS)	Voice / Data	1 710.7 MHz ~ 1 754.3 MHz
LTE FDD Band 5 (Cell)	Voice / Data	824.7 MHz ~ 848.3 MHz
LTE FDD Band 12	Voice / Data	699.7 MHz ~ 715.3 MHz
LTE FDD Band 13	Voice / Data	779.5 MHz ~ 784.5 MHz
LTE FDD Band 17	Voice / Data	706.5 MHz ~ 713.5 MHz
LTE FDD Band 26	Voice / Data	814.7 MHz ~ 848.3 MHz
LTE TDD Band 41	Voice / Data	2 498.5 MHz ~ 2 687.5 MHz
LTE FDD Band 66 (AWS)	Voice / Data	1 710.7 MHz ~ 1 779.3 MHz
NR FDD Band n5	Voice / Data	826.5 MHz ~ 846.5 MHz
NR TDD Band n41	Voice / Data	2 501.01 MHz ~ 2 685 MHz
NR FDD Band n66	Voice / Data	1 712.5 MHz ~ 1 777.5 MHz
NR TDD Band n77	Voice / Data	3 705 MHz ~ 3 975 MHz
NR TDD Band n77 DoD	Voice / Data	3 445.01 MHz ~ 3 544.98 MHz
U-NII-1	Voice / Data	5 180 MHz ~ 5 240 MHz
U-NII-2A	Voice / Data	5 260 MHz ~ 5 320 MHz
U-NII-2C	Voice / Data	5 500 MHz ~ 5 720 MHz
U-NII-3	Voice / Data	5 745 MHz ~ 5 825 MHz
2.4 GHz WLAN	Voice / Data	2 412 MHz ~ 2 462 MHz
Bluetooth / LE	Data	2 402 MHz ~ 2 480 MHz
NFC	Data	13.56 MHz
Device Description		
Device Serial Numbers	Mode	Serial Number
	2G/3G/4G/5G Sub6 NR	ZD23215M, ZC910424M
	The manufacturer has confirmed that the devices tested have the same physical, mechanical and thermal characteristics are within operational tolerances expected for production units.	

Measurement Plot Summary Table

Test Case#	Test Scenario	Tech	Band	Antenna	DSI	Channel	Frequency	Plot No.
1	Time-varying Tx power transmission	LTE	2	A	0	18700	1 860	1
2			41	C	0	41055	2 636.5	2
3		UMTS	4	A	0	1413	1 732.6	3
4		GPRS	1900	A	0	661	1 880	4
5		Sub6 NR	66	F	1	349000	1 745	5
6			77	G	0	633334	3 500.01	6
7	Change in Call	Sub6 NR	77	G	0	633334	3 500.01	7
8	*Tech/Band Switch	LTE	2	A	0	18700	1 860	8
		UMTS	4	A	0	1413	1 732.6	
9	*DSI Switch	Sub6 NR	77	G	0	633334	3 500.01	9
			77	G	1	633334	3 500.01	
10	*Antenna Switch	LTE	66	F	0	132322	1 745	10
			41	C	0	41055	2 636.5	
11	*Time Window	Sub6 NR	66	F	0	349000	1 745	11,12
			77	G	0	633334	3 500.01	
12	*SAR1 vs SAR2	LTE	5	A	0	20252	836.5	13
		Sub6 NR	66	A	0	349000	1 745	
13	*Inter Uplink CA Switch	LTE	5	A	0	20525	836.5	14
		LTE	66	A	0	132072	1 720	
14	*Exposure category switch Head to non-head to head	Sub6 NR	77	G	1	633334	3 500.01	15
			77	G	0	633334	3 500.01	
15	*Exposure category switch non-Head to head to non-head	Sub6 NR	77	G	0	633334	3 500.01	16
			77	G	1	633334	3 500.01	

3.2 Test Under Dynamic Transmission Condition for RF Exposure Compliance

The equipment under test (EUT), models SM-A276B/DS and SM-A276B (FCC ID: A3LSMA276B), employs Qualcomm modems supporting 2G, 3G, 4G, and 5G NR (Sub-6) operation. WLAN, Bluetooth, and NFC are not covered by the Qualcomm Smart Transmit functionality. The Qualcomm modems are configured with the Smart Transmit feature to dynamically control and manage transmit power in real time, thereby ensuring continuous compliance with the FCC time-averaged RF exposure requirements

This feature performs time averaging algorithm in real time to control and manage transmitting power and ensure the time-averaged RF exposure is in compliance with FCC requirements all the time.

The Smart Transmit algorithm maintains the time-averaged transmit power, in turn, time-averaged RF exposure of SAR_design_target for sub 6 radio, below the predefined time averaged power limit for each characterized technology and band.

Smart Transmit allows the device to transmit at higher power instantaneously, as high as Pmax, when needed, but enforces power limiting to maintain time-averaged transmit power to Plimit for frequencies < 6 GHz and input.power.limit for frequencies > 6 GHz.

DUT Contains embedded file system (EFS) version 20 configured for second generation (GEN2) phase IV(GEN2.4+)

EFS v20 Verification

Per Qualcomm document 80-W2112-5, products implementing Embedded File System (EFS) Version 20 shall be verified for the applicable Smart Tx generation based on the relevant MCC settings. It was confirmed that the DUT includes EFS Version 20 configured for Smart Tx Second Generation, Phase IV (GEN2.4+) for Sub-6 operation under the MCC settings applicable to the U.S. market.

EFS v20 Generation	MCC
GEN2_SUB6	310

The purpose of this Part 2 report is to demonstrate compliance of the EUT with the FCC RF exposure requirements under transmission scenarios involving varying Tx conditions, and thereby to validate the applicability of the Qualcomm Smart Transmit feature for the FCC equipment authorization of FCC ID: A3LSMA276B

Note that the device uncertainty for sub 6GHz WWAN is 1.0dB for this DUT.

o Tx_power_at_SAR_design_target (Plimit in dBm) for Tx transmitting frequency < 6 GHz The maximum time-average transmit power, in dBm, at which this radio configuration (i.e., band and technology) reaches the SAR_design_target. This SAR_design_target is predetermined for the specific device and it shall be less than regulatory SAR limit after accounting for all design related tolerances. The time-averaged SAR is assessed against this SAR_design_target in real time to determine the compliance. The Plimit could vary with technology, band, antenna and DSI (device state index), therefore it has the unique value for each technology, band, antenna and DSI.

The reserve margin for WWAN radios can be configured for each sub6 antenna group, and each exposure category as shown below:

For a given exposure category (head vs. non-head) and antenna group, OEM can configure:

o TOTAL_MIN_RES_RATIO

This entry corresponds to the minimum reserve margin for WWAN radio when operating in standalone mode per antenna group. Here, TOTAL_MIN_RES_RATIO is 0.5.

o WWAN_PRI_SPLIT_RATIO, WWAN_SEC_SPLIT_RATIO

In multi-Tx scenarios in the same antenna group, minimum reserve for each active radio (i.e., WWAN primary radio, WWAN secondary radio) is a product of the corresponding fraction out of sum of active radio split ratios and TOTAL_MIN_RES_RATIO.

In case of WWAN primary and WWAN secondary simultaneous transmission in the same antenna group, the minimum reserve for each radio, respectively, are:

o $TOTAL_MIN_RES_RATIO * \{WWAN_PRI_SPLIT_RATIO$

```

/ (WWAN_PRI_SPLIT_RATIO+WWAN_SEC_SPLIT_RATIO)}
o TOTAL_MIN_RES_RATIO * {WWAN_SEC_SPLIT_RATIO
/ (WWAN_PRI_SPLIT_RATIO+WWAN_SEC_SPLIT_RATIO)}

```

■ Multi_Tx_factor: ONLY applicable for Smart Transmit EFS version 19 (or higher).

The EFS version 19 (or higher) provides the entry to improve performance of sub6 radios in simultaneous transmission scenarios.

With EFS version 19: In single Tx transmission scenarios, Smart Transmit ensures time-averaged RF exposure is $\leq (\text{SAR_design_target} * 10(+ \text{sub6 device uncertainty}/10)) < \text{regulatory RF exposure limit for sub6 radio}$ managed by Smart Transmit. In simultaneous Tx transmission scenarios, Smart Transmit ensures time-averaged RF exposure is $\leq (\text{SAR_design_target} * \text{multi_Tx_factor} * 10(+ \text{sub6 device uncertainty}/10)) < \text{regulatory RF exposure limit for sub6 radios}$ managed by Smart Transmit. These simultaneous transmission scenarios are listed below:

- 2-or-more radio scenarios within WWAN like EN-DC, LTE ULCA, etc.

The multi_Tx_factor can be determined using

$$\text{Multi-Tx Factor} \leq \frac{\text{Regulatory SAR Limit}^\dagger}{\text{SAR Design Target} \times 10^{\left(\frac{\text{Sub-6 Device Uncertainty (dB)}}{10}\right)}} = \frac{\text{Regulatory SAR Limit}^\dagger}{\text{Reported SAR}}$$

Footnote

† Regulatory SAR limit may be reduced to satisfy specific requirements, such as antenna grouping.

Notes

- If only two WLAN radios are transmitting, for example 2.4 GHz + 5 GHz, the Multi-Tx Factor is not applied by Smart Transmit.
- If the WWAN modem is offline, for example in airplane mode, the Multi-Tx Factor is not applied by Smart Transmit for simultaneous WLAN and Bluetooth transmission.

■ Hand exposure applicability when device held next to head: Yes/No switch. ONLY applicable for Smart Transmit EFS version 19 (or higher).

If “Yes” is selected in Smart Transmit EFS version 19 (or higher) for the country/region of interest, then Smart Transmit will ensure time-averaged RF exposure compliance in both hand and head tissue regions when device is held next to head in a voice call. Otherwise, if “No” is selected, then Smart Transmit will ensure time-averaged RF exposure compliance only in head tissue region when device is held next to head.

This purpose of the Part 2 report is to demonstrate the DUT complies with FCC RF exposure requirement under Tx varying transmission scenarios, thereby validity of Qualcomm® Smart Transmit feature implementation in this device. It serves to compliment the Part 0 and Part 1 Test Reports to justify compliance per FCC

All Part 2 tests of this device were conducted according to the guidelines of the Qualcomm document 80-W2112-5.

■ Test case reduction for multiple filings

Per the Guidance of the FCC and Qualcomm (Document No: 80-W2112-5, Sec.4.2,)

For multiple filings with same chipset, the test case reduction proposal for Part 2 testing is:

1. Full set of tests in the first filing, i.e., both power measurement and RF exposure measurement, are required.
 2. For all subsequent filings with the same chipset, only power measurement (scenarios (a) – (i)) is required. In the case of scenario (a) time-varying Tx transmission test, only one band (instead of two bands) per technology is sufficient
- ✓ The time-varying tests for this model (A3LSMA276B) were evaluated applying test case reduction.

■ **Regulatory body configuration:**

Based on regulatory requirement for each countries/regions, FCC time window/limits and/or ICNIRP 1998 time window/limits can be selected and/or combined. Additionally, Time-Averaged Exposure mode or Peak Exposure mode can be selected based on MCC for Smart Transmit to operate. In Time-Averaged Exposure mode, the wireless device can instantaneously transmit at high transmit powers and exceed the Plimit for a short duration before limiting the power to maintain the time-averaged transmit power under the Plimit; while in Peak Exposure mode, the maximum instantaneous transmit power is limited to Plimit. Depending on EFS version, regulatory body configuration is different.

■ ***force peak* for Tx transmitting frequency**

The Smart Transmit feature applies time-averaging windows when the device detects an MCC that matches Time-Averaged Exposure MCCs list. For each of the MCCs under Time-Averaged Exposure MCCs list, the Smart Transmit feature can limit either maximum peak power or maximum time-average power to Plimit per tech/band/antenna/DSI. If force peak is set to '2' for a given tech/band/antenna/DSI in the EFS, then the Smart Transmit feature limits the maximum Tx power to Plimit for the selected tech/band/antenna/DSI. In other words, with force peak set to '2', under static condition (i.e., fixed tech/band/antenna/DSI) and in single active Tx scenario, Smart Transmit can guarantee Tx power level of Plimit at all times.

The EFS Version of A3LSMA276B is EFS ver.20

This device was tested in part 2 of Tx Varying transmission(Time-Averaged Exposure mode) testing using US MCC (310).and MCC , '2' was used to test the peak exposure mode.

4. Tx Varying Transmission Test Cases and Test Proposal

To validate time averaging feature and demonstrate the compliance in Tx varying transmission conditions, the following transmission scenarios are covered in Part 2 test:

1. During a time-varying Tx power transmission: To prove that the Smart Transmit feature accounts for Tx power variations in time accurately.
2. During a call disconnect and re-establish scenario: To prove that the Smart Transmit feature accounts for history of past Tx power transmissions accurately.
3. During technology/band handover: To prove that the Smart Transmit feature functions correctly during transitions in technology/band.
4. During DSI (Device State Index) change: To prove that the Smart Transmit feature functions correctly during transition from one device state (DSI) to another.
5. During antenna (or beam) switch: To prove that the Smart Transmit feature functions correctly during transitions in antenna (such as AsDiv scenario) or beams (different antenna array configurations).
6. During time window switch: To prove that the Smart Transmit feature correctly handles the transition from one time window to another specified by FCC, and maintains the normalized time-averaged RF exposure to be less than normalized FCC limit of 1.0 at all times.
7. SAR exposure switching between two active radios (radio1 and radio2): To prove that the Smart Transmit feature functions correctly and ensures total RF exposure compliance when exposure varies among SAR_radio1 only, SAR_radio1 + SAR_radio2, and SAR_radio2 only scenarios.
8. Exposure Category Switch: This evaluation is intended to verify that the Smart Transmit feature functions correctly during transitions from head exposure to body-worn exposure, and vice versa. Exposure continuity is controlled under two categories: head exposure and non-head exposure.

NOTE: Technology in this test refers to WWAN

As described in Part 0 report, the RF exposure is proportional to the Tx power for a SAR- characterized wireless device. Thus, feature validation in Part 2 can be effectively performed through conducted (for $f < 6\text{GHz}$) and radiated (for $f \geq 6\text{GHz}$) power measurement. Therefore, the compliance demonstration under dynamic transmission conditions and feature validation are done in conducted/radiated power measurement setup for transmission scenario 1 through 8.

- The strategy for testing in Tx varying transmission condition is outlined as follows:

Demonstrate the total RF exposure averaged over FCC defined time windows does not exceed FCC's SAR limits, through time-averaged power measurements

- Measure conducted Tx power (for $f < 6\text{GHz}$) versus time.
- Convert it into RF exposure and divide by respective FCC limits to get normalized exposure versus time.
- Perform running time-averaging over FCC defined time windows.
- Demonstrate that the total normalized time-averaged RF exposure is less than 1 for all transmission scenarios (i.e., transmission scenarios 1, 2, 3, 4, 5, 6, 7,8) at all times.

Mathematical expression:

$$1g_or_10gSAR(t) = \frac{conducted_Tx_power(t)}{conducted_Tx_power_Plimit} * 1g_or_10gSAR_Plimit \quad (1a)$$

$$\frac{\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t 1g_or_10gSAR(t) dt}{FCC\ SAR\ limit} \leq 1 \quad (1b)$$

where, $conducted_Tx_power(t)$, $conducted_Tx_power_Plimit$, and $1g_or_10gSAR_Plimit$ correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at Plimit, and measured 1gSAR or 10gSAR values at Plimit corresponding to sub-6 transmission. Plimit and input.power.limit are the parameters pre-defined in Part 0 and loaded via Embedded File System (EFS) onto the EUT. TSAR is the FCC defined time window for sub-6 radio.

Demonstrate the total RF exposure averaged over FCC defined time windows does not exceed FCC's SAR limits, through time-averaged SAR measurements. Note as mentioned earlier, this measurement is performed for transmission scenario 1 only.

For sub-6 transmissions only, measure instantaneous SAR versus time; for LTE+sub6 NR transmission, request low power (or all-down bits) on LTE so that measured SAR predominantly corresponds to sub6NR.

Convert it into RF exposure and divide by respective FCC limits to obtain normalized exposure versus time. Perform time averaging over FCC defined time window.

Demonstrate that the total normalized time-averaged RF exposure is less than 1 for transmission scenario 1 at all times.

Mathematical expression:

$$1g_or_10gSAR(t) = \frac{pointSAR(t)}{pointSAR_Plimit} * 1g_or_10gSAR(t)_Plimit \quad (3a)$$

$$\frac{\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t 1g_or_10gSAR(t) dt}{FCC\ SAR\ limit} \leq 1 \quad (3b)$$

where, $pointSAR(t)$, $pointSAR_Plimit$ and $1g_or_10gSAR_Plimit$ correspond to the measured instantaneous point SAR, measured point SAR at Plimit, and measured 1gSAR or 10gSAR values at Plimit corresponding to sub-6 transmission.

Note: cDASY6 measurement system by Schmid & Partner Engineering AG (SPEAG) of Zurich, Switzerland measures relative E-field versus time

5. SAR Time Averaging Validation Test Procedures

This chapter provides the test plan and test procedure for validating Qualcomm Smart Transmit feature for sub-6 transmission. The 100 seconds time window for operating $f < 3\text{GHz}$ is used as an example to detail the test procedures in this chapter. The same test plan and test procedures described in this chapter apply to 60 seconds time window for operating $f \geq 3\text{GHz}$.

5.1 Test sequence determination for validation

Following the FCC recommendation, two test sequences having time-variation in Tx power are predefined for sub-6 ($f < 6\text{GHz}$) validation:

- Test sequence 1: request EUT's Tx power to be at maximum power, measured $P_{max}^{\dagger}$, for 80s, then requesting for half of the maximum power, i.e., measured $P_{max}/2$, for the rest of the time.
- Test sequence 2: request EUT's Tx power to vary with time. This sequence is generated relative to measured P_{max} , measured P_{limit} and calculated $P_{reserve}$ (= measured P_{limit} in dBm - $Reserve_power_margin$ in dB) of EUT based on measured P_{limit} .

NOTE: See Section 2.3, for EUT enabled with Smart Transmit EFS version 17 or lower, $Reserve_power_margin$ (dB) is a global parameters and applies to all WWAN technologies.

For EUT enabled with Smart Transmit EFS version 18 (or higher):

$Reserve_power_margin$ (dB) = $Reserve_power_margin_db_2g_3g_wwan$ for 2G and 3G WWAN technology;

$Reserve_power_margin$ (dB) = $-10 \cdot \log_{10}(\text{total_min_exp_budget_linear_4g_5g_wwan})$ for 4G and 5G technology.

The details for generating these two test sequences is described and listed in Appendix A.

NOTE: For test sequence generation, “measured P_{limit} ” and “measured P_{max} ” are used instead of the “ P_{limit} ” specified in EFS entry and “ P_{max} ” specified for the device, because Smart Transmit feature operates against the actual power level of the “ P_{limit} ” that was calibrated for the EUT. The “measured P_{limit} ” accurately reflects what the feature is referencing to, therefore, it should be used during feature validation testing. The RF tune up and device- to-device variation are already considered in Part 0 report prior to determining P_{limit} .

5.2 Test configuration selection criteria for validating Smart Transmit feature

For validating Smart Transmit feature, this section provides a general guidance to select test cases. In practice, an adjustment can be made in test case selection. The justification/clarification may be provided.

5.2.1 Test configuration selection for time-varying Tx power transmission

The Smart Transmit time averaging feature operation is independent of bands, modes, and channels for a given technology. Hence, validation of Smart Transmit in one band/mode/channel per technology is sufficient. Two bands per technology are proposed and selected for this testing to provide high confidence in this validation.

The criteria for the selection are based on the P_{limit} values determined in Part 0 report. Select two bands* in each supported technology that correspond to least** and highest*** P_{limit} values that are less than P_{max} for validating Smart Transmit.

*If one P_{limit} level applies to all the bands within a technology, then only one band needs to be tested. In this case, within the bands having the same P_{limit} , the radio configuration (e.g., # of RBs, channel#) and device position that correspond to the highest $measured\ 1gSAR$ at P_{limit} shown in Part 1 report is selected.

** In case of multiple bands having the same least P_{limit} within the technology, The “least P_{limit} ” term also implies that the technology/band with the largest difference between P_{max} and P_{limit} ($P_{limit} < P_{max}$) should be considered in the selection.

*** The band having a higher P_{limit} needs to be properly selected so that the power limiting enforced by Smart Transmit can be validated using the pre-defined test sequences. If the highest P_{limit} in a technology is too high where the power limiting enforcement is not needed when testing with the pre-defined test sequences, then the next highest level is checked. This process is continued within the technology until the second band for validation testing is determined.

5.2.2 Test configuration selection for change in call

The criteria to select a test configuration for call-drop measurement is:

- Select technology/band with least P_{limit} among all supported technologies/bands, and select the radio configuration (e.g., # of RBs, channel#) in this technology/band that corresponds to the highest *measured* 1gSAR at P_{limit} listed in Part 1 report.
- In case of multiple bands having same least P_{limit} , then select the band having the highest *measured* 1gSAR at P_{limit} in Part 1 report.
- Test for change in call is not required if all $P_{limit} > P_{max}$

This test is performed with the EUT's Tx power requested to be at maximum power, the above band selection will result in Tx power enforcement (i.e., EUT forced to have Tx power at *Preserve*) for longest duration in one FCC defined time window. The call change (call drop/reestablish) is performed during the Tx power enforcement duration (i.e., during the time when EUT is forced to have Tx power at *Preserve*). One test is sufficient as the feature operation is independent of technology and band.

5.2.3 Test configuration selection for change in technology/band

The selection criteria for this measurement is, for a given antenna, to have EUT switch from a technology/band with lowest P_{limit} within the technology group (in case of multiple bands having the same P_{limit} , then select the band with highest *measured* 1gSAR at P_{limit}) to a technology/band with highest P_{limit} within the technology group, in case of multiple bands having the same P_{limit} , then select the band with lowest *measured* 1gSAR at P_{limit} in Part 1 report, or vice versa.

This test is performed with the EUT's Tx power requested to be at maximum power, the technology/band switch is performed during Tx power enforcement duration (i.e., during the time when EUT is forced to have Tx power at *Preserve*).

5.2.4 Test configuration selection for change in antenna

The criteria to select a test configuration for antenna switch measurement is:

- Whenever possible and supported by the EUT, first select antenna switch configuration within the same technology/band (i.e., same technology and band combination) and having different P_{limit} , and having both $P_{limit} < P_{max}$ where possible. Otherwise, select at least one antenna having $P_{limit} < P_{max}$.
- In case of multiple bands having same difference in P_{limit} among supported antennas, then select the band having the highest *measured* 1gSAR at P_{limit} in Part 1 report.

This test is performed with the EUT's Tx power requested to be at maximum power in selected technology/band, and antenna change is conducted during Tx power enforcement duration (i.e., during the time when EUT is forced to have Tx power at *Preserve*).

5.2.5 Test configuration selection for change in DSI

The criteria to select a test configuration for DSI change test is

- Select a technology/band having the $P_{limit} < P_{max}$ within any technology and DSI group, and for the same technology/band having a different P_{limit} in any other DSI group. Note that the selected DSI transition need to be supported by the device.

NOTE: The antennas corresponding to the selected DSIs should be in the same antenna group if EUT is configured with GEN2_SUB6, and selected DSIs should be under the same exposure category (i.e., both selected DSIs are either under head exposure category or under non-head exposure category) if EUT is enabled with Smart Transmit version 18 or higher.

This test is performed with the EUT's Tx power requested to be at maximum power in selected technology/band, and DSI change is conducted during Tx power enforcement duration (i.e., during the time when EUT is forced to have Tx power at $P_{reserve}$).

5.2.6 Test configuration selection for change in time window

FCC specifies different time window for time averaging based on operation frequency. The criteria to select a test configuration for validating Smart Transmit feature and demonstrating the compliance during the change in time window is

- Select any technology/band that has operation frequency classified in one-time window defined by FCC (such as 100-seconds time window), and its corresponding P_{limit} is less than P_{max} if possible.
- Select the 2nd technology/band that has operation frequency classified in a different time window defined by FCC (such as 60-seconds time window), and its corresponding P_{limit} is less than P_{max} if possible.
- It is preferred both P_{limit} values of two selected technologies/band less than corresponding P_{max} , but if not possible, at least one of technologies/bands has its P_{limit} less than P_{max} .

Note The antennas corresponding to the selected radio configurations for this test should be in the same antenna group if EUT is configured with GEN2_SUB6

This test is conducted with the EUT configured such that the Tx power is requested at the maximum level for the selected technology and band. Testing one selected pair of time windows is considered sufficient, as the feature operation is identical for the relevant time-window combinations.

5.2.7 Test configuration selection for SAR exposure switching

If supported, the test configuration for SAR exposure switching should cover

1. SAR exposure switch when two active radios are in the same time window
(a. LTE+sub6 NR, b. Inter-band ULCA)
2. SAR exposure switch when two active radios are in different time windows. One test with two active radios in any two different time windows is sufficient as Smart Transmit operation is the same for RF exposure switch in any combination of two different time windows.

The Smart Transmit time averaging operation is independent of the source of SAR exposure (for example, LTE vs. Sub6 NR) and ensures total time-averaged RF exposure compliance. Hence, validation of Smart Transmit in any one simultaneous SAR transmission scenario (i.e., one combination for LTE + Sub6 NR transmission) is sufficient, where the SAR exposure varies among SARradio1 only, SARradio1 + SARradio2, and SARradio2 only scenarios.

The criteria to select a test configuration for validating Smart Transmit feature during SAR exposure switching scenarios is

- Select any two < 6GHz technologies/bands that the EUT supports simultaneous transmission (for example, LTE+Sub6NR).
- Among all supported simultaneous transmission configurations, the selection order is
 - 1) select one configuration where both P_{limit} of radio1 and radio2 is less than their corresponding P_{max} , preferably, with different P_{limits} . If this configuration is not available, then
 - 2) select one configuration that has P_{limit} less than its P_{max} for at least one radio. If this cannot be found, then
 - 3) select one configuration that has P_{limit} of radio1 and radio2 greater than P_{max} but with least

$(P_{limit} - P_{max})_{\text{delta}}$.

Test for one simultaneous transmission scenario is sufficient as the feature operation is the same.

5.2.8 Test configuration selection for exposure category switch

The criteria to select a test configuration for exposure category switch measurement is:

o If the device's intended exposure mode is configured for time averaged exposure mode operation, then:

If $P_{limit} < P_{max}$ for at least one radio out of all supported technology/band/antenna/DSI, then:

1) Out of all head exposure DSIs, select a technology/band/antenna/DSI having the least P_{limit} ($< P_{max}$), furthermore, having the largest difference between P_{max} and P_{limit} ($P_{limit} < P_{max}$) should be considered in the selection. Then, select a second DSI in the non-head exposure category DSI that has the least P_{limit} among all the non-head DSIs for the same technology/band/antenna. This technology/band/antenna and selected DSIs are used for head to non-head to head exposure switch test. If the $P_{limit} > P_{max}$ for all supported technology/band/antenna/DSI in head exposure category, then this test is not required.

2) Similarly, out of all non-head exposure DSIs, select a technology/band/antenna/DSI having the least P_{limit} ($< P_{max}$), furthermore, having the largest difference between P_{max} and P_{limit} ($P_{limit} < P_{max}$) should be considered in the selection. Then, select a second DSI in the head exposure category DSI that has the least P_{limit} among all the head DSIs for the same technology/band/antenna. This technology/band/antenna and selected DSIs are used for nonhead to head to non-head exposure switch test. If the $P_{limit} > P_{max}$ for all supported technology/band/antenna/DSI in non-head exposure category, then this test is not required.

If $P_{limit} > P_{max}$ for all supported technology/band/antenna/DSIs for both head and non-head DSI categories, then:

3) select a supported sub6 simultaneous transmission scenario (like LTE + FR1 NSA or FR1 interband NR-DC, etc.) in head DSI that has $P_{limit} < P_{max} + 10 \cdot \log(N)$ for all radios of selected technology(s)/band(s)/antenna(s), where N is the number of active radios in selected sub6 simultaneous transmission scenario. Note that the antennas determined for the selected radios of simultaneous transmission scenario should be in the same antenna group if EUT is configured with GEN2_SUB6. Then, select a second DSI in the non-head exposure category that has the lowest P_{limit} among all the non-head DSIs for all the radios of the selected technology(s)/band(s)/antenna(s) simultaneous transmission scenario. This selected technology(s)/band(s)/antenna(s) and selected DSIs are used for head to non-head to head exposure switch test. If the head DSI has $P_{limit} > P_{max} + 10 \cdot \log(N)$ for all radios supported in sub6 simultaneous transmission scenarios, then this test is not required.

4) select a supported sub6 simultaneous transmission scenario (like LTE + FR1 NSA, or FR1 interband NR-DC, etc.) in non-head DSI that has $P_{limit} < P_{max} + 10 \cdot \log(N)$ for all radios of the selected technology(s)/band(s)/antenna(s), where N is the number of active radios in selected sub6 simultaneous transmission scenario.

Note that the antennas determined for the selected radios of simultaneous transmission scenario should be in the same antenna group if EUT is configured with GEN2_SUB6. Then, select a second DSI in the head exposure category that has the lowest P_{limit} among all the head DSIs for all the radios of the selected technology(s)/band(s)/antenna(s) simultaneous transmission scenario. This selected technology(s)/band(s)/antenna(s) and selected DSIs are used for non-head to head to non-head exposure switch test. If the non-head DSI has $P_{limit} > P_{max} + 10 \cdot \log(N)$ for all radios supported in sub6 simultaneous transmission scenarios, then this test is not required.

Use the highest measured 1g_or_10g SAR at P_{limit} ($P_{limit} < P_{max}$) shown in Part 1 report for the selected tech/band/antenna/DSI out of all radio configurations and device positions in Equation (3a), (4a), (5a) and (6a) to calculate time-varying SAR. However, in the case of $P_{limit} > P_{max}$, the SAR measured in Part 1 report for the corresponding radio configuration selected and tested in Part 2 should be applied in Equation (3a), (4a), (5a) and (6a).

If the device's intended exposure mode is configured for peak exposure mode operation, then:

1) Select a supported sub6 simultaneous transmission scenario (like LTE + FR1 NSA, or FR1 interband NR-DC, etc.) in head DSI that has $P_{limit} < P_{max} + 10 \cdot \log(N)$ for all radios of selected technology(s)/band(s)/antenna(s), where N is the number of active radios in selected sub6 simultaneous transmission scenario. Note that the antennas determined for the selected radios of simultaneous transmission scenario should be in the same antenna group if EUT is configured with GEN2_SUB6. Then, select a second DSI in the non-head exposure category that has the lowest P_{limit} among all the non-head DSIs for all the radios of the selected technology(s)/band(s)/antenna(s) simultaneous transmission scenario. This selected technology(s)/band(s)/antenna(s) and selected DSIs are used for head to non-head to head exposure switch test. If the head DSI has $P_{limit} > P_{max} + 10 \cdot \log(N)$ for all radios supported in sub6 simultaneous transmission scenarios, then this test is not required.

2) Select a supported sub6 simultaneous transmission scenario (like LTE + FR1 NSA, or FR1 interband NR-DC, etc.) in non-head DSI that has $P_{limit} < P_{max} + 10 \cdot \log(N)$ for all radios of the selected technology(s)/band(s)/antenna(s), where N is the number of active radios in selected sub6 simultaneous transmission scenario. Note that the antennas determined for the selected radios of simultaneous transmission scenario should be in the same antenna group if EUT is configured with GEN2_SUB6. Then, select a second DSI in the head exposure category that has the lowest P_{limit} among all the head DSIs for all the radios of the selected technology(s)/band(s)/antenna(s) simultaneous transmission scenario. This selected technology(s)/band(s)/antenna(s) and selected DSIs are used for non-head to head to non-head exposure switch test. If the non-head DSI has $P_{limit} > P_{max} + 10 \cdot \log(N)$ for all radios supported in sub6 simultaneous transmission scenarios, then this test is not required.

□ Use the highest measured 1g_or_10g SAR at P_{limit} ($P_{limit} < P_{max}$) shown in Part 1 report for the selected tech/band/antenna/DSI out of all radio configurations and device positions in Equation (3a), (4a), (5a) and (6a) to calculate time-varying SAR. However, in the case of $P_{limit} > P_{max}$, the SAR measured in Part 1 report for the corresponding radio configuration selected and tested in Part 2 should be applied in Equation (3a), (4a), (5a) and (6a).

5.3 Test procedures for conducted power measurements

This section provides general conducted power measurement procedures to perform compliance test under dynamic transmission scenarios described in Section 4. In practice, an adjustment can be made in these procedures. The justification/clarification may be provided.

5.3.1 Time-varying Tx power transmission scenario

This test is performed with the two pre-defined test sequences described in Section 5.1 for all the technologies and bands selected in Section 5.2.1. The purpose of the test is to demonstrate the effectiveness of power limiting enforcement and that the time-averaged SAR (corresponding time-averaged Tx power) does not exceed the FCC limit at all times (see Eq. (1a) and (1b)).

Test procedure

1. Measure P_{max} , measure P_{limit} and calculate Preserve (= measured P_{limit} in dBm –

Reserve_power_margin in dB) and follow Section 5.1 to generate the test sequences for all the technologies and bands selected in Section 5.2.1. Both test sequence 1 and test sequence 2 are created based on measured P_{max} and measured P_{limit} of the EUT. Test condition to measure P_{max} and P_{limit} is:

- Measure P_{max} with Smart Transmit disabled and callbox set to request maximum power.
- Measure P_{limit} with Smart Transmit enabled and *Reserve_power_margin* set to 0 dB, callbox set to request maximum power.

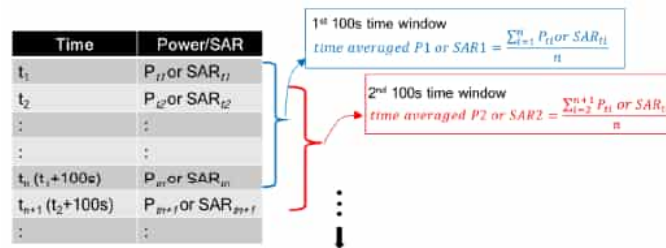
2. Set *Reserve_power_margin* to actual (intended) value and reset power on EUT to enable Smart Transmit, establish radio link in desired radio configuration, with callbox requesting the EUT's Tx power to be at pre-defined test sequence 1, measure and record Tx power versus time, and then convert the conducted Tx power into 1gSAR or 10gSAR value (see Eq. (1a)) using measured P_{limit} from above Step 1. Perform running time average to determine time-averaged power and 1gSAR or 10gSAR versus time as illustrated

in Figure 5-1 where using 100-seconds time window as an example.

NOTE: In Eq.(1a), instantaneous Tx power is converted into instantaneous 1gSAR or 10gSAR value by applying the measured worst-case 1gSAR or 10gSAR value at P_{limit} for the corresponding technology/band/antenna/DSI reported in Part 1 report.

NOTE: For an easier computation of the running time average, 0 dBm can be added at the beginning of the test sequences the length of the responding time window, for example, add 0dBm for 100-seconds so the running time average can be directly performed starting with the first 100-seconds data using excel spreadsheet. This technique applies to all tests performed in this Part 2 report for easier time-averaged computation using excel spreadsheet.

Figure 5-1 100s running average illustration



3. Make one plot containing:

- Instantaneous Tx power versus time measured in Step2,
- Requested Tx power used in Step 2 (test sequence1),
- Computed time-averaged power versus time determined in Step2,
- Time-averaged power limit (corresponding to FCC SAR limit of 1.6 W/kg for 1gSAR or 4.0W/kg for 10gSAR) givenby

$$\text{Time avearged power limit} = \text{meas. } P_{limit} + 10 \times \log\left(\frac{\text{FCC SAR limit}}{\text{meas. SAR_Plimit}}\right) \quad (5a)$$

where $\text{meas. } P_{limit}$ and meas. SAR_Plimit correspond to measured power at P_{limit} and measured SAR at P_{limit} .

4. Make another plot containing:

- Computed time-averaged 1gSAR or 10gSAR versus time determined in Step2
 - FCC $1gSAR_{limit}$ of 1.6W/kg or FCC $10gSAR_{limit}$ of 4.0W/kg.
- Repeat Steps 2 ~ 4 for pre-defined test sequence 2 and replace the requested Tx power (test sequence 1) in Step 2 with test sequence2.
 - Repeat Steps 2 ~ 5 for all the selected technologies and bands.

The validation criteria are, at all times, the time-averaged power versus time shown in Step 3 plot shall not exceed the time-averaged power limit (defined in Eq. (5a)), in turn, the time-averaged 1gSAR or 10gSAR versus time shown in Step 4 plot shall not exceed the FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR (i.e., Eq. (1b)).

5.3.2 Change in call scenario

This test is to demonstrate that Smart Transmit feature accurately accounts for the past Tx powers during time-averaging when a new call is established.

The call disconnects and re-establishment needs to be performed during power limit enforcement, i.e., when the EUT's Tx power is at $P_{reserve}$ level, to demonstrate the continuity of RF exposure management and limiting in call change scenario. In other words, the RF exposure averaged over any FCC defined time window (including the time windows containing the call change) doesn't exceed FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

Test procedure

1. Measure P_{limit} for the technology/band selected in Section 5.2.2. Measure P_{limit} with Smart Transmit enabled and $Reserve_power_margin$ set to 0 dB, callbox set to request maximum power.
2. Set $Reserve_power_margin$ to actual (intended) value and reset power on EUT to enable Smart Transmit.
3. Establish radio link with callbox in the selected technology/band.
4. Request EUT's Tx power at 0 dBm for at least one time window specified for the selected technology/band, followed by requesting EUT's Tx power to be at maximum power for about ~60 seconds, and then drop the call for ~10 seconds. Afterwards, re-establish another call in the same radio configuration (i.e., same technology/band/channel) and continue callbox requesting EUT's Tx power to be at maximum power for the remaining time of at least another full duration of the specified time window. Measure and record Tx power versus time. Once the measurement is done, extract instantaneous Tx power versus time, convert the measured conducted Tx power into 1gSAR or 10gSAR value using Eq. (1a), and then perform the running time average to determine time-averaged power and 1gSAR or 10gSAR versus time.

NOTE: In Eq.(1a), instantaneous Tx power is converted into instantaneous 1gSAR or 10gSAR value by applying the measured worst-case 1gSAR or 10gSAR value at P_{limit} for the corresponding technology/band/antenna/DSI reported in Part 1 report.

5. Make one plot containing: (a) instantaneous Tx power versus time, (b) requested power, (c) computed time-averaged power, (d) time-averaged power limit calculated using Eq.(5a).
6. Make another plot containing: (a) computed time-averaged 1gSAR or 10gSAR versus time, and (b) FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

The validation criteria are, at all times, the time-averaged power versus time shall not exceed the time-averaged power limit (defined in Eq.(5a)), in turn, the time-averaged 1gSAR or 10gSAR versus time shall not exceed the FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR (i.e., Eq. (1b)).

5.3.3. Change in technology and band

This test is to demonstrate the correct power control by Smart Transmit during technology switches and/or band handovers.

Similar to the change in call test in Section 5.2.3, to validate the continuity of RF exposure limiting during the transition, the technology and band handover needs to be performed when EUT's Tx power is at $P_{reserve}$ level (i.e., during Tx power enforcement) to make sure that the EUT's Tx power from previous $P_{reserve}$ level to the new $P_{reserve}$ level (corresponding to new technology/band). Since the P_{limit} could vary with technology and band, Eq. (1a) can be written as follows to convert the instantaneous Tx power in 1gSAR or 10gSAR exposure for the two given radios, respectively:

$$1g_or_10gSAR_1(t) = \frac{conducted_Tx_power_1(t)}{conducted_Tx_power_Plimit_1} * 1g_or_10gSAR_Plimit_1 \quad (6a)$$

$$1g_or_10gSAR_2(t) = \frac{conducted_Tx_power_2(t)}{conducted_Tx_power_Plimit_2} * 1g_or_10gSAR_Plimit_2 \quad (6b)$$

$$\frac{1}{T_{SAR}} \left[\int_{t-T_{SAR}}^{t_1} \frac{1g_or_10gSAR_1(t)}{FCC\ SAR\ limit} dt + \int_{t-T_{SAR}}^t \frac{1g_or_10gSAR_2(t)}{FCC\ SAR\ limit} dt \right] \leq 1 \quad (6c)$$

where, $conducted_Tx_power_1(t)$, $conducted_Tx_power_Plimit_1$, and $1g_or_10gSAR_Plimit_1$ correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at P_{limit} , and measured 1gSAR or 10gSAR value at P_{limit} of technology1/band1; $conducted_Tx_power_2(t)$, $conducted_Tx_power_Plimit_2(t)$, and $1g_or_10gSAR_Plimit_2$ correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at P_{limit} , and measured 1gSAR or 10gSAR value at P_{limit} of technology2/band2. Transition from technology1/band1 to the technology2/band2 happens at time-instant ' t_I '.

Test procedure

1. Measure P_{limit} for both the technologies and bands selected in Section 5.2.3. Measure P_{limit} with Smart Transmit enabled and *Reserve_power_margin* set to 0 dB, callbox set to request maximum power.
2. Set *Reserve_power_margin* to actual (intended) value and reset power on EUT to enable Smart Transmit
3. Establish radio link with callbox in first technology/band selected.
4. Request EUT's Tx power at 0 dBm for at least one time window specified for the selected technology/band, followed by requesting EUT's Tx power to be at maximum power for about ~60 seconds, and then switch to second technology/band selected. Continue with callbox requesting EUT's Tx power to be at maximum power for the remaining time of at least another full duration of the specified time window. Measure and record Tx power versus time for the full duration of the test.
5. Once the measurement is done, extract instantaneous Tx power versus time, and convert the conducted Tx power into 1gSAR or 10gSAR value using Eq. (6a) and (6b) and corresponding measured P_{limit} values from Step 1 of this section. Perform the running time average to determine time-averaged power and 1gSAR or 10gSAR versus time.

NOTE: In Eq.(6a) & (6b), instantaneous Tx power is converted into instantaneous 1gSAR or 10gSAR value by applying the measured worst-case 1gSAR or 10gSAR value at P_{limit} for the corresponding technology/band/antenna/DSI reported in Part 1 report.

6. Make one plot containing: (a) instantaneous Tx power versus time, (b) requested power, (c) computed time-averaged power, (d) time-averaged power limit calculated using Eq.(5a).
7. Make another plot containing: (a) computed time-averaged 1gSAR or 10gSAR versus time, and (b) FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

The validation criteria are, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed the FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR (i.e., Eq. (6c)).

5.3.4 Change in antenna

This test is to demonstrate the correct power control by Smart Transmit during antenna switches from one antenna to another. The test procedure is identical to Section 5.2.4, by replacing technology/band switch operation with antenna switch. The validation criteria are, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

5.3.5 Change in DSI

This test is to demonstrate the correct power control by Smart Transmit during DSI switches from one DSI to another. The test procedure is identical to Section 5.2.5, by replacing technology/band switch operation with DSI switch. The validation criteria are, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

5.3.6 Change in time window

This test is to demonstrate the correct power control by Smart Transmit during the change in averaging time window when a specific band handover occurs. FCC specifies time-averaging windows of 100s for Tx frequency < 3GHz, and 60s for Tx frequency between 3GHz and 6GHz.

To validate the continuity of RF exposure limiting during the transition, the band handover test needs to be performed when EUT handovers from operation band less than 3GHz to greater than 3GHz and vice versa. The equations (3a) and (3b) in Section 4 can be written as follows for transmission scenario having change in time window,

$$1gSAR_1(t) = \frac{\text{conducted_Tx_power_1}(t)}{\text{conducted_Tx_power_Plimit_1}} * 1g_or\ 10g_SAR_Plimit_1 \quad (7a)$$

$$1gSAR_2(t) = \frac{\text{conducted_Tx_power_2}(t)}{\text{conducted_Tx_power_Plimit_2}} * 1g_or\ 10g_SAR_Plimit_2 \quad (7b)$$

$$\frac{1}{T1SAR} \left[\int_{t-T1SAR}^{t_1} \frac{1g_or\ 10g_SAR_1(t)}{FCC\ SAR\ limit} dt \right] + \frac{1}{T2SAR} \left[\int_{t-T2SAR}^t \frac{1g_or\ 10g_SAR_2(t)}{FCC\ SAR\ limit} dt \right] \leq 1 \quad (7c)$$

where, *conducted_Tx_power_1(t)*, *conducted_Tx_power_Plimit_1*, and *1g_or 10g_SAR_Plimit_1* correspond to the instantaneous Tx power, conducted Tx power at *Plimit*, and compliance *1g_or 10g_SAR* values at *Plimit_1* of band1 with time-averaging window '*T1SAR*'; *conducted_Tx_power_2(t)*, *conducted_Tx_power_Plimit_2*, and *1g_or 10g_SAR_Plimit_2* correspond to the instantaneous Tx power, conducted Tx power at *Plimit*, and compliance *1g_or 10g_SAR* values at *Plimit_2* of band2 with time-averaging window '*T2SAR*'. One of the two bands is less than 3GHz, another is greater than 3GHz. Transition from first band with time-averaging window '*T1SAR*' to the second band with time-averaging window '*T2SAR*' happens at time-instant '*t1*'.

Test procedure

1. Measure *Plimit* for both the technologies and bands selected in Section 5.2.6. Measure *Plimit* with Smart Transmit *enabled* and *Reserve_power_margin* set to 0 dB, callbox set to request maximum power.
2. Set *Reserve_power_margin* to actual (intended) value and enable Smart Transmit

Transition from 100s time window to 60s time window, and vice versa

3. Establish radio link with callbox in the technology/band having 100s time window selected in Section 5.2.6.
4. Request EUT's Tx power to be at 0 dBm for at least 100 seconds, followed by requesting EUT's Tx power to be at maximum power for about ~140 seconds, and then switch to second technology/band (having 60s time window) selected in Section 5.2.6. Continue with callbox requesting EUT's Tx power to be at maximum power for about ~60s in this second technology/band, and then switch back to the first technology/band. Continue with callbox requesting EUT's Tx power to be at maximum power for at least another 100s. Measure and record Tx power versus time for the entire duration of the test.
5. Once the measurement is done, extract instantaneous Tx power versus time, and convert the conducted Tx power into 1gSAR or 10gSAR value (see Eq. (7a) and (7b)) using corresponding technology/band Step 1 result, and then perform 100s running average to determine time-averaged 1gSAR or 10gSAR versus time. Note that in Eq.(7a) & (7b), instantaneous Tx power is converted into instantaneous 1gSAR or 10gSAR value by applying the worst-case 1gSAR or 10gSAR value tested in Part 1 for the selected technologies/bands at *Plimit*.
6. Make one plot containing: (a) instantaneous Tx power versus time measured in Step4.
7. Make another plot containing: (a) instantaneous 1gSAR versus time determined in Step 5, (b) computed time-averaged 1gSAR versus time determined in Step 5, and (c) corresponding regulatory *1gSARlimit* of 1.6W/kg or *10gSARlimit* of 4.0W/kg.

Transition from 60s time window to 100s time window, and vice versa

8. Establish radio link with callbox in the technology/band having 60s time window selected in Section 5.2.6.
9. Request EUT's Tx power to be at 0 dBm for at least 60 seconds, followed by requesting EUT's Tx power to be at maximum power for about ~80 seconds, and then switch to second technology/band (having 100s time window) selected in Section 5.2.6. Continue with callbox requesting EUT's Tx power to be at maximum power for about ~100s in this second technology/band, and then switch back to the first technology/band. Continue with callbox requesting EUT's Tx power to be at maximum power for the remaining time for a total test time of 500 seconds. Measure and record Tx power versus time for the entire duration of the test.
10. Repeat above Step 5~7 to generate the plots

The validation criteria is, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed the regulatory *1gSARlimit* of 1.6W/kg or *10gSARlimit* of 4.0W/kg.

5.3.7 SAR exposure switching

This test is to demonstrate that Smart Transmit feature is accurately accounts for switching in exposures among SAR from radio1 only, SAR from both radio1 and radio2, and SAR from radio2 only scenarios, and ensures total time-averaged RF exposure complies with the FCC limit. The detailed test procedure for SAR exposure switching in the case of LTE+Sub6 NR non- standalone mode transmission scenario is provided in Appendix B.2.

Test procedure:

1. Measure conducted Tx power corresponding to *P_{limit}* for radio1 and radio2 in selected band. Test condition to measure conducted *P_{limit}* is:
 - Establish device in call with the callbox for radio1 technology/band. Measure conducted Tx power corresponding to radio1 *P_{limit}* with Smart Transmit enabled and *Reserve_power_margin* set to 0 dB, callbox set to request maximum power.
 - Repeat above step to measure conducted Tx power corresponding to radio2 *P_{limit}*. If radio2 is dependent on radio1 (for example, non-standalone mode of Sub6 NR requiring radio1 LTE as anchor), then establish radio1 + radio2 call with callbox, and request all down bits for radio1 LTE. In this scenario, with callbox requesting maximum power from radio2 Sub6 NR, measured conducted Tx power corresponds to radio2 *P_{limit}* (as radio1 LTE is at all-downbits)
2. Set *Reserve_power_margin* to actual (intended) value, with EUT setup for radio1 + radio2 call. In this description, it is assumed that radio2 has lower priority than radio1. Establish device in radio1+radio2 call, and request all-down bits or low power on radio1, with callbox requesting EUT's Tx power to be at maximum power in radio2 for at least one time window. After one time window, set callbox to request EUT's Tx power to be at maximum power on radio1, i.e., all-up bits. Continue radio1+radio2 call with both radios at maximum power for at least one time window, and drop (or request all-down bits on) radio2. Continue radio1 at maximum power for at least one time window. Record the conducted Tx power for both radio1 and radio2 for the entire duration of this test.
3. Once the measurement is done, extract instantaneous Tx power versus time for both radio1 and radio2 links. Convert the conducted Tx power for both these radios into 1gSAR or 10gSAR value (see Eq. (6a) and (6b)) using corresponding technology/band *P_{limit}* measured in Step 1, and then perform the running time average to determine time-averaged 1gSAR or 10gSAR versus time.
4. Make one plot containing: (a) instantaneous Tx power versus time measured in Step2.
5. Make another plot containing: (a) instantaneous 1gSAR versus time determined in Step 3, (b) computed time-averaged 1gSAR versus time determined in Step 3, and (c) corresponding regulatory *1gSARlimit* of 1.6W/kg or *10gSARlimit* of 4.0W/kg.

The validation criteria is, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed the regulatory *1gSARlimit* of 1.6W/kg or *10gSARlimit* of 4.0W/kg.

5.3.8 Exposure category switch

This test is performed with the EUT being requested to transmit at maximum power in selected technology/band/antenna/DSI. The change in exposure category is preferably performed during Tx power enforcement (i.e., EUT forced to transmit at a sustainable level). One test is sufficient as this feature operation is independent of technology, band and antenna. Test procedure are:

In case of head to non-head to head exposure switch test, 'first DSI' in below test procedure refers to head DSI and 'second DSI' refers to non-head DSI. Similarly, in case of non-head to head to non-head

exposure switch test, 'first DSI' in below test procedure refers to non-head DSI and 'second DSI' refers to head DSI.

1. Measure Plimit for all the technology(s)/band(s)/antenna(s)/DSI(s) selected following the above selection criteria. Measure Plimit with Smart Transmit Peak exposure mode enabled and callbox set to request maximum power.
2. Set EUT to intended Smart Transmit exposure mode.
3. Establish radio link with first DSI and with callbox in the selected technology(s)/band(s)/antenna(s).
4. Request EUT to transmit at 0 dBm for at least 100 seconds, followed by requesting EUT to transmit at maximum Tx power for the active radio(s) for half of the regulatory time window, and then switch to the second DSI for ~10s, and switch back to the first DSI for at least one time window. Throughout this test, when switching between DSIs (i.e., switching between exposure categories), continue with callbox requesting EUT to transmit at maximum Tx power for the active radio(s). Measure and record Tx power versus time for the entire duration of the test.
5. Once the measurement is done, extract instantaneous Tx power versus time, and convert the conducted Tx power into 1g_or_10gSAR value (see Eq. (7a) and (7b)) using the corresponding Plimit measured in Step 1 and 1g_or_10gSAR value measured in 80-W2112-4 Part 1 report, and then perform 100s running average to determine time-averaged 1g_or_10gSAR versus time as illustrated in Figure 5-1. Note that in Eq.(7a) & (7b), instantaneous Tx power is converted into instantaneous 1g_or_10gSAR value by applying the worst-case 1gSAR value for the selected technologies/bands at Plimit as reported in 80-W2112-4 Part 1 report.
6. Make one plot containing: (a) computed time-averaged normalized 1g_or_10gSAR of the selected technology(s)/band(s)/antenna(s) versus time determined in Step 5 for exposure under first DSI, (b) total time-averaged normalized exposure for exposure under first DSI if simultaneous transmission scenario was tested, and (c) normalized regulatory limit of 1.0.
7. Make another plot containing: (a) computed time-averaged 1g_or_10gSAR of the selected technology(s)/band(s)/antenna(s) versus time determined in Step 5 for exposure under second DSI, (b) total time-averaged normalized exposure for exposure under second DSI if simultaneous transmission scenario was tested, and (c) normalized regulatory limit of 1.0.

The validation criteria is, at all times, the time-averaged normalized exposure versus time shall not exceed the normalized limit of 1.0 for both first & second DSIs (i.e., both head exposure category and non-head exposure category)

6. Test Configurations

6.1 WWAN (sub-6)transmission

The *P_{limit}* values, corresponding to 1.0 W/kg (1gSAR) and 2.5 W/kg (10gSAR) of *SAR_{design_target}*, for technologies and bands supported by EUT are derived in Part 0 report and summarized in Table 6-1. Note all *P_{limit}* power levels entered in Table 6-1 correspond to average power levels after accounting for duty cycle in the case of TDD modulation schemes.

Plimit values in green indicate Plimit ≤ Pmax				Plimit values in grey indicate Plimit > Pmax		
Plimit corresponding to 1 W/kg (1g) 2.5W/kg(10g) SAR_Design_target						Pmax
SAR Exposure Position			Non-Head Bodyworn Hotspot	Head (RCV ON)	Phablet	Maximum Tune-up Output Power [dBm]
Averaging volume			1g	1g	10g	
separation Distance			5,10 mm	0 mm	0 mm	
Mode	Antenna	Antenna Group	DSI=0	DSI=1	DSI=0	
GSM/GPRS/EDGE 850	A	AG0	22.8	29.0	22.8	25.1
GSM/GPRS/EDGE1900	A	AG0	19.3	28.8	19.3	22.6
UMTS Band 2	A	AG0	20.5	21.5	20.5	23.5
UMTS Band 4	A	AG0	20.0	29.0	20.0	23.0
UMTS Band 5	A	AG0	23.5	23.5	23.5	24.5
LTE Band 2	A	AG0	18.0	28.1	18.0	23.5
LTE Band 5	A	AG0	24.0	27.7	24.0	24.5
LTE Band 12/17	A	AG0	26.7	27.3	26.7	24.0
LTE Band 13	A	AG0	26.0	27.7	26.0	24.0
LTE Band 26	A	AG0	25.9	27.2	25.9	24.0
LTE Band 41	A	AG0	17.0	25.6	17.0	23.5
LTE Band 41	C	AG1	11.5	17.0	11.5	23.0
LTE Band 4/66	A	AG0	20.0	29.8	20.0	24.0
LTE Band 4/66	F	AG1	20.0	18.0	20.0	24.0
NR Band n5	A	AG0	24.0	26.6	24.0	24.5
NR Band n41	A	AG0	17.0	27.0	17.0	23.5
NR Band n41 SRS1	E	AG1	17.0	17.0	17.0	20.0
NR Band n41 SRS2	C	AG1	10.0	17.0	10.0	21.0
NR Band n41 SRS3	K	AG1	17.0	17.0	17.0	19.0
NR Band n66	A	AG0	20.0	29.2	20.0	24.0
NR Band n66	F	AG1	20.0	18.0	20.0	24.0
NR Band n71	A	AG0	26.1	28.0	26.1	24.0
NR Band n77 / n77 DoD(PC3)	G	AG1	14.0	16.0	14.0	23.5
NR Band n77 / n77 DoD SRS1 (PC3)	D	AG1	14.0	14.0	14.0	20.5
NR Band n77 / n77 DoD SRS2 (PC3)	I	AG1	14.0	16.0	14.0	21.5
NR Band n77 / n77 DoD SRS3 (PC3)	H	AG1	14.0	16.0	14.0	18.5
NR Band n77 / n77 DoD (PC2)	G	AG1	14.0	16.0	14.0	23.5
NR Band n77 / n77 DoD SRS1 (PC2)	D	AG1	14.0	14.0	14.0	20.5
NR Band n77 / n77 DoD SRS2 (PC2)	I	AG1	14.0	16.0	14.0	21.5
NR Band n77 / n77 DoD SRS3 (PC2)	H	AG1	14.0	16.0	14.0	18.5

Table 6-1: *P_{limit}* for supported technologies and bands (*P_{limit}* in setting)

* Maximum tune up target power, *P_{max}*, is configured in NV settings in EUT to limit maximum transmitting power. This power is converted into peak power in NV settings for TDD schemes. The EUT maximum allowed output power is equal to *P_{max}* + 1dB device uncertainty.

Based on selection criteria described in Section 5.2, the selected technologies/bands for testing time-varying test sequences are highlighted in yellow in Table 6-1.

As per Part 1 report, the Reserve_power_margin(dB) for Samsung Mobile Phone (FCC ID: A3LSMA276B) is set to calculate Preserve in EFS, and is used in Part 2 test. The radio configurations used in Part 2 test for selected technologies, bands, DSIs and antennas are listed in Table 6-1. The corresponding worst-case radio configuration 1gSAR or 10gSAR values for selected technology/band/DSI are extracted from Part 1 report and are listed in the last column of Table 6-2.

Based on equations (1a), (2a), (3a) and (4a), it is clear that Part 2 testing outcome is normalized quantity, which implies that it can be applied to any radio configuration within a selected technology/band/DSI. Thus, as long as applying the worst-case SAR obtained from the worst radio configuration in Part 1 testing to calculate time-varying SAR exposure in equations (1a), (2a), (3a) and (4a), the accuracy in compliance demonstration remains the same.

Test Case #	Test Scenario	Tech	Band	Antenna	DSI	Channel	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Mode	SAR Exposure Scenario	Part 1 Worst Case Measured SAR at Plimit (W/kg)
1	Time-varying Tx power transmission	LTE	2	A	0	18700	1 860	1/99/20 MHz BW	QPSK	Body, Rear, 5mm	0.335
2			41	C	0	41055	2 636.5	1/0/20 MHz BW	QPSK	Body, Rear, 5mm	0.758
3		UMTS	4	A	0	1413	1 732.6	-	RMC	Body, Bottom, 10mm	0.506
4		GPRS	1900	A	0	661	1 880	-	GPRS, 2 Tx	Body, Rear, 5mm	0.433
5		Sub6 NR	66	F	1	349000	1 745	1/214/40 MHz BW	QPSK	Head, Right Cheek, 0mm	0.479
6			77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	0.657
7	Change in Call	Sub6 NR	77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	0.657
8	*Tech/Band Switch	LTE	2	A	0	18700	1 860	1/99/20 MHz BW	QPSK	Body, Rear, 5mm	0.335
		UMTS	4	A	0	1413	1 732.6	-	RMC	Body, Bottom, 10mm	0.506
9	*DSI Switch	Sub6 NR	77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	0.657
			77	G	1	633334	3 500.01	1/1/100 MHz BW	QPSK	Head, Right Cheek, 0mm	0.331
10	*Antenna Switch	LTE	66	F	0	132322	1 745	1/0/20 MHz BW	QPSK	Body, Rear, 5mm	0.376
			41	C	0	41055	2 636.5	1/0/20 MHz BW	QPSK	Body, Rear, 5mm	0.758
11	*Time Window	Sub6 NR	66	F	0	349000	1 745	1/214/40 MHz BW	QPSK	Body, Rear, 5mm	0.476
			77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	0.657
12	*SAR1 vs SAR2	LTE	5	A	0	20252	836.5	1/0/10 MHz BW	QPSK	Body, Rear, 5mm	0.740
		Sub6 NR	66	A	0	349000	1 745	1/108/40 MHz BW	QPSK	Body, Rear, 5mm	0.699
13	*Inter Uplink CA Switch	LTE	5	A	0	20525	836.5	1/0/10 MHz BW	QPSK	Body, Rear, 5mm	0.740
			66	A	0	132072	1 720	1/49/20 MHz BW	QPSK	Body, Rear, 5mm	0.736
14	*Exposure category switch Head to non-head to head	Sub6 NR	77	G	1	633334	3 500.01	1/1/100 MHz BW	QPSK	Head, Right Cheek, 0mm	0.331
			77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	0.657
15	*Exposure category switch non-Head to head to non-head	Sub6 NR	77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	0.657
			77	G	1	633334	3 500.01	1/1/100 MHz BW	QPSK	Head, Right Cheek, 0mm	0.331

Table 6-2: Radio configurations selected for Part 2 test

* total time-averaged normalized RF exposure limit

This device uses different Device State Index (DSI) to configure different time averaged power levels based on certain exposure scenarios.

Scenario	Description	SAR Test Cases
Head (DSI = 1)	Device positioned next to head	Head SAR per KDB Publication 648474 D04
Bodyworn Phablet Hotspot (DSI = 0)	Device is held with hand Device being used with a body-worn accessory Device transmits in hotspot mode near body	Phablet SAR per KDB Publication 648474 D04 Body-worn SAR per KDB Publication 648474 D04 Hotspot SAR per KDB Publication 941225 D06

Based on the selection criteria described in Section 5.2, the radio configurations for the Tx varying transmission test cases listed in Section 7 are:

1. Technologies and bands for time-varying Tx power transmission: The test case 1~6 listed in Table 6-2 are selected to test with the test sequences defined in Section 5.2.1 in both time- varying conducted power measurement and time-varying SAR measurement. Note that only one GSM band were selected as the second band for these technologies has P_{limit} greater than P_{max} , requiring no Tx power limitation.
2. Technology and band for change in call test: Following the guidelines in Section 5.2.2 NR band (test case 7 in Table 6-2) is selected for performing the call drop test in conducted power setup.
3. Technologies and bands for change in technology/band test: Following the guidelines in Section 5.2.3, test case 8 in Table 6-2 is selected for handover test from a technology/band/antenna with lowest P_{limit} within one technology group, to a technology/band in the same DSI with highest P_{limit} within another technology group in conducted power setup.
4. Technologies and bands for change in DSI: Based on selection criteria in Section 5.2.5, for a given technology and band, test case 9 in Table 6-2 is selected for DSI switch test by establishing a call in DSI = 0, and then handing over to DSI = 1 condition scenario in conducted power setup.
5. Technologies and bands for change in antenna: Based on selection criteria in Section 5.2.4, for a given DSI, test case 10 in Table 6-2 is selected for antenna switch in conducted power setup.
6. Technologies and bands for change in time-window: Based on selection criteria in Section 5.2.6, for a given DSI, test case 11 in Table 6-2 is selected for time window switch between 60s window (over 3GHz) and 100s window (under 3GHz), 100s window (under 3GHz) and 60s window (over 3GHz) in conducted power setup.
7. Technologies and bands for switch in SAR exposure: Based on selection criteria in Section 5.2.7 Scenario 1, test case 12, 13 in Table 6-2 is selected for SAR exposure switching test in one of the supported simultaneous WWAN transmission scenario, i.e., LTE + Sub6 NR or PCC + SCC active in the same 100s time window, in conducted power setup.
8. Technologies and bands for switch in exposure category: Based on selection criteria in Section 5.2.8, test case 14, 15 in Table 6-2 is selected for switch in exposure category test by establishing a call in DSI=1, handing over to DSI=0, and then handing over back to DSI=1 scenario in conducted power setup.

7. Time-varying Tx power measurement for below 6GHz frequency

7.1 Conducted Measurement Test setup

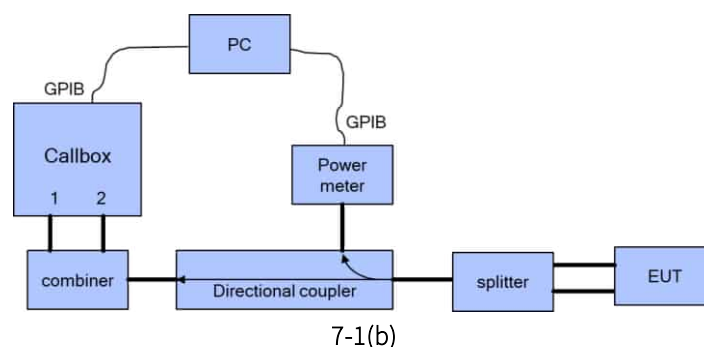
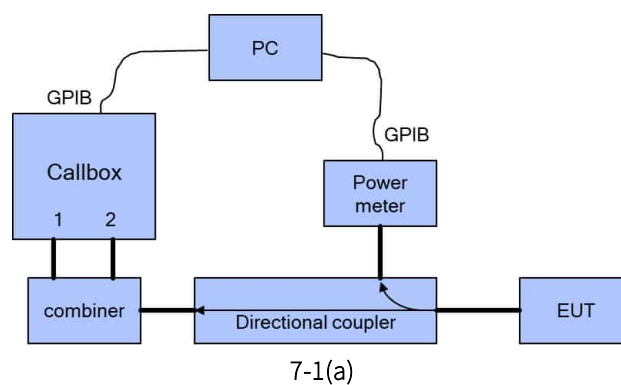
Legacy Test Setup

The Rohde & Schwarz CMW500 callbox is used in this test. The test setup picture and schematic are shown in Figures 8-1a for measurements with a single antenna of EUT (see Appendix C–The test Setup Photo 1).and in Figures 8-1b for measurements involving antenna switch (see Appendix C The test Setup Photo 2).

For single antenna measurement, one port (RF1 COM) of the callbox is connected to the RF port of the EUT using a directional coupler. For antenna & technology switch measurement, two ports (RF1 COM and RF3 COM) of the callbox used for signaling two different technologies are connected to a combiner, which is in turn connected to a directional coupler. The other end of the directional coupler is connected to a splitter to connect to two RF ports of the EUT corresponding to the two antennas of interest. In both the setups, power meter is used to tap the directional coupler for measuring the conducted output power of the EUT. For time averaging validation test (Section 5.3.1), call drop test (Section 5.3.2), and DSI switch test (Section 5.3.4), only RF1 COM port of the callbox is used to communicate with the EUT. For technology/band switch measurement (Section. 5.3.3), both RF1 COM and RF3 COM port of callbox are used to switch from one technology communicating on RF1 COM port to another technology communicating on RF3 COM port. All the path losses from RF port of EUT to the callbox RF COM port and to the power meter are calibrated and automatically entered as offsets in the callbox and the power meter via test scripts on the PC used to control callbox and power meter.

LTE+Sub6 NR test setup:

If LTE conducted port and Sub6 NR conducted port are same on this EUT (i.e., they share the same antenna), then low-/high-pass filter is used to separate LTE and Sub6 NR signals for power meter measurement via directional couplers, as shown in below Figures 8-1(c) (see Appendix C- Test setup photo-3)



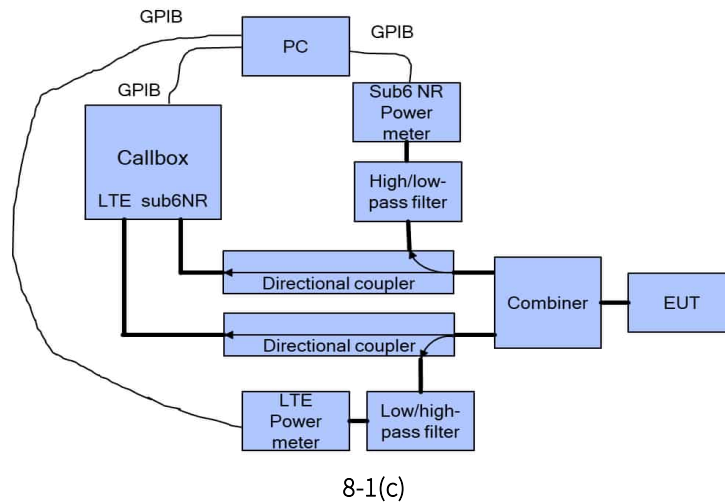


Figure 7-1 Conducted power measurement setup

Both the callbox and power meter are connected to the PC using GPIB cables. Two test scripts are custom made for automation, and the test duration set in the test scripts is 600 seconds.

For time-varying Tx power measurement, the PC runs the 1st test script to send GPIB commands to control the callbox's requested power versus time, while at the same time to record the conducted power measured at EUT RF port using the power meter. The commands sent to the callbox to request power are:

- 0dBm for 100 seconds
- test sequence 1 or test sequence 2 (defined in Section 5.1 and generated in Section 5.5.1), for 360 seconds
- stay at the last power level of test sequence 1 or test sequence 2 for the remaining time.

Power meter readings are periodically recorded every 100ms. A running average of this measured Tx power over 100 seconds is performed in the post-data processing to determine the 100s-time averaged power. For call drop, technology/band/antenna switch, and DSI switch tests, after the call is established, the callbox is set to request the EUT's Tx power at 0dBm for 100 seconds while simultaneously starting the 2nd test script runs at the same time to start recording the Tx power measured at EUT RF port using the power meter. After the initial 100 seconds since starting the Tx power recording, the callbox is set to request maximum power from the EUT for the rest of the test.

Note that the call drop/re-establish, or technology/band/antenna switch or DSI switch is manually performed when the Tx power of EUT is at *Preserve* level. See Section 5.3 for detailed test procedure of call drop test, technology/band/antenna switch test and DSI switch test.

7.2 *P_{limit}* and *P_{max}* measurement Results

The measured *P_{limit}* for all the selected radio configurations given in Table 6-1 are listed in below Table 7-1. *P_{max}* was also measured for radio configurations selected for testing time-varying Tx power transmission scenarios in order to generate test sequences following the test procedures in Section 5.1.

Test Case #	Test Scenario	Tech	Band	Antenna	DSI	Channel	Frequency [MHz]	RB/IRB Offset/Bandwidth (MHz)	Mode	SAR Exposure Scenario	Plimit EFS Setting[dBm]	Tune Up Target Power Pmax[dBm]	Measured Plimit [dBm]	Measured Pmax [dBm]	Part 1 Worst Case Measured SAR at Plimit (W/kg)
1	Time-varying Tx power transmission	LTE	2	A	0	18700	1 860	1/99/20 MHz BW	QPSK	Body, Rear, 5mm	18.00	23.50	17.71	23.52	0.335
2			41	C	0	41055	2 636.5	1/0/20 MHz BW	QPSK	Body, Rear, 5mm	11.00	21.00	11.02	20.66	0.758
3		UMTS	4	A	0	1413	1 732.6	-	RMC	Body, Bottom, 10mm	20.00	23.00	20.42	23.36	0.506
4			1900	A	0	661	1 880	-	GPRS, 2 Tx	Body, Rear, 5mm	20.30	22.30	20.18	22.61	0.433
5		Sub6 NR	66	F	1	349000	1 745	1/214/40 MHz BW	QPSK	Head, Right Cheek, 0mm	18.00	24.00	18.23	24.22	0.479
6			77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	14.00	23.50	13.59	22.58	0.657
7	Change in Call	Sub6 NR	77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	14.00	23.50	13.59	22.58	0.657
8	*Tech/Band Switch	LTE	2	A	0	18700	1 860	1/99/20 MHz BW	QPSK	Body, Rear, 5mm	18.00	23.50	17.71	23.52	0.335
		UMTS	4	A	0	1413	1 732.6	-	RMC	Body, Bottom, 10mm	20.00	23.00	20.42	23.36	0.506
9	*DSI Switch	Sub6 NR	77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	14.00	23.50	13.59	22.58	0.657
			77	G	1	633334	3 500.01	1/1/100 MHz BW	QPSK	Head, Right Cheek, 0mm	16.00	23.50	15.61	22.58	0.331
10	*Antenna Switch	LTE	66	F	0	132322	1 745	1/0/20 MHz BW	QPSK	Body, Rear, 5mm	20.00	24.00	19.05	23.20	0.376
			41	C	0	41055	2 636.5	1/0/20 MHz BW	QPSK	Body, Rear, 5mm	11.50	21.00	11.02	20.66	0.758
11	*Time Window	Sub6 NR	66	F	0	349000	1 745	1/214/40 MHz BW	QPSK	Body, Rear, 5mm	20.00	24.00	20.21	24.22	0.476
			77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	14.00	23.50	13.59	22.58	0.657
12	*SAR1 vs SAR2	LTE	5	A	0	20252	836.5	1/0/10 MHz BW	QPSK	Body, Rear, 5mm	24.00	24.50	23.68	24.18	0.740
		Sub6 NR	66	A	0	349000	1 745	1/108/40 MHz BW	QPSK	Body, Rear, 5mm	20.00	24.00	20.54	24.02	0.699
13	*Inter Uplink CA Switch	LTE	5	A	0	20525	836.5	1/0/10 MHz BW	QPSK	Body, Rear, 5mm	24.00	24.50	23.68	24.18	0.740
			66	A	0	132072	1 720	1/49/20 MHz BW	QPSK	Body, Rear, 5mm	20.00	24.00	19.90	23.99	0.736
14	*Exposure category switch Head to non-head to head	Sub6 NR	77	G	1	633334	3 500.01	1/1/100 MHz BW	QPSK	Head, Right Cheek, 0mm	16.00	23.50	15.61	22.58	0.331
			77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	14.00	23.50	13.59	22.58	0.657
15	*Exposure category switch non-Head to head to non-head	Sub6 NR	77	G	0	633334	3 500.01	1/137/100 MHz BW	QPSK	Body, Rear, 5mm	14.00	23.50	13.59	22.58	0.657
			77	G	1	633334	3 500.01	1/1/100 MHz BW	QPSK	Head, Right Cheek, 0mm	16.00	23.50	15.61	22.58	0.331

Table 7-1: Measured Plimit and Pmax of selected radio configuration

*Total time-averaged normalized RF Exposure limit

Note:

1. The device uncertainty of P_{max} is +1dB/-1.5dB as provided by manufacturer.
2. The above P_{max} / P_{limit} value for GPRS1900 is Frame Averaged Power for 2Tx Slots
3. Tests including duty-cycle transmit are normalized to frame average.
4. Due to a limitation of the available test equipment, a modified procedure was used for Sub6 NR TDD Cases. The relevant parameters are shown below. On the above table, NR Band n77 measured P_{max} and Measured P_{limit} values represent P_{max_seq} and P_{limit_seq} . Section B.2 contains more details about the modified procedure used for NR Band n77 evaluation.

7.3 Time-varying Tx power measurement results

The measurement setup is shown in Figures 7-1(a), 7-1(b) and 7-1(c). The purpose of the time-varying Tx power measurement is to demonstrate the effectiveness of power limiting enforcement and that the time-averaged Tx power when represented in time-averaged 1gSAR or 10gSAR values does not exceed FCC limit as shown in Eq. (1a) and (1b), rewritten below:

$$1g_or_10gSAR(t) = \frac{conducted_Tx_power(t)}{conducted_Tx_power_P_{limit}} * 1g_or_10gSAR_P_{limit} \quad (1a)$$

$$\frac{\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t 1g_or_10gSAR(t) dt}{FCC\ SAR\ limit} \leq 1 \quad (1b)$$

where, $conducted_Tx_Power(t)$, $conducted_Tx_P_{limit}$, and $1g_or_10g\ SAR_P_{limit}$ correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at P_{limit} , and measured 1gSAR and 10gSAR values at P_{limit} reported in Part 1 test (listed in Table 6-2 of this report as well).

Following the test procedure in Section 5.3, the conducted Tx power measurement for all selected configurations are reported in this section. In all the conducted Tx power plots, the dotted line represents the requested power by callbox (test sequence 1 or test sequence 2), the blue curve represents the instantaneous conducted Tx power measured using power meter, the green curve represents time-averaged power and red line represents the conducted power limit that corresponds to FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

Similarly, in all the 1g or 10gSAR plots (when converted using Eq. (1a)), the green curve represents the 100s time averaged 1gSAR or 10gSAR value calculated based on instantaneous 1gSAR or 10gSAR; and the red line limit represents the FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

Time-varying Tx power measurements were conducted on test cases #1 ~ #6 in Table 7-1 by generating test sequence 1 and test sequence 2 given in Appendix A using measured P_{limit} and measured P_{max} for each of these test cases. Measurement results for test cases #1 ~ #6 are given in Sections 7.3.1 - 7.3.5.

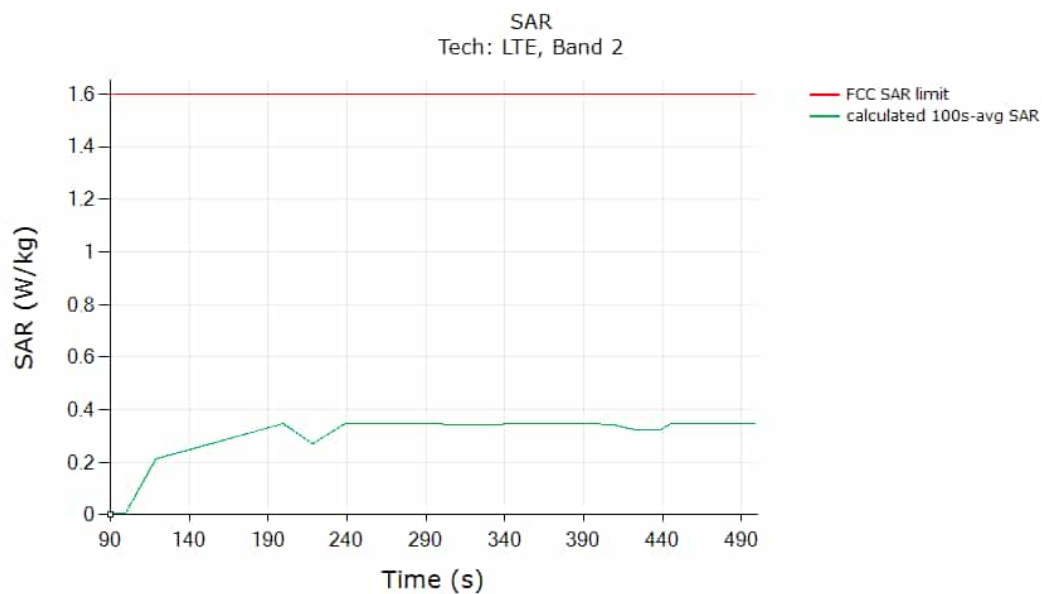
7.3.1 LTE Band 2 (test case 1 in Table 6-2)

Plot No. 1

Test result for test sequence 1:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR

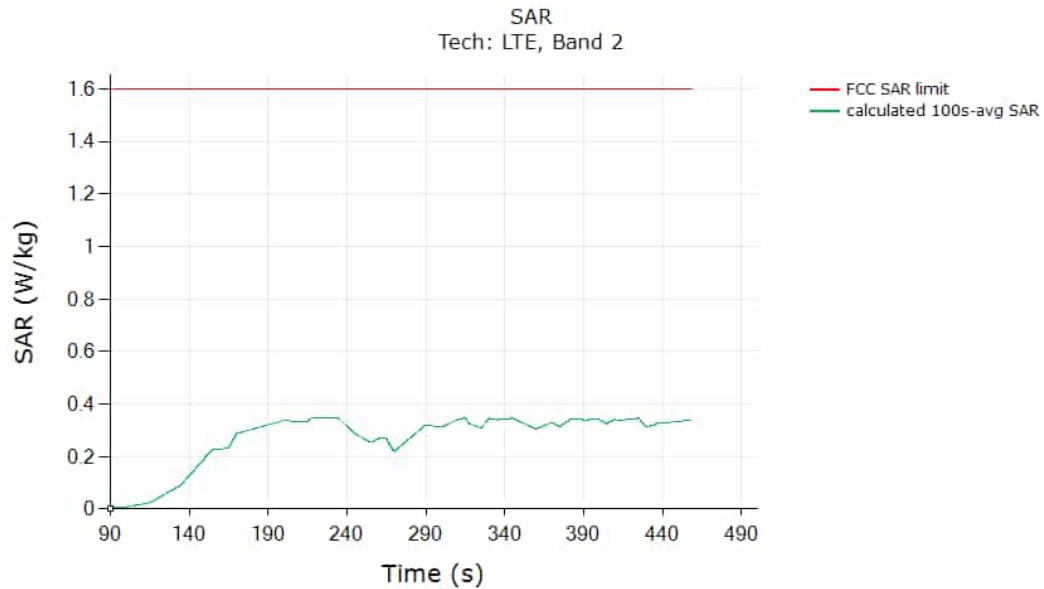
Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured <i>P</i> _{limit} [dBm]	Measured <i>P</i> _{max} [dBm]	Part 1 Worst Case Measured SAR at <i>P</i> _{limit} (W/kg)
LTE	B2	A	0	1 860	1/99/20 MHz BW	17.71	23.52	0.335



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1gSAR (green curve)	0.347 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P</i> _{limit} (last column in Table 7-1).	

Test result for test sequence 2:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1gSAR (green curve)	0.346 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P</i> _{limit} (last column in Table 7-1).	

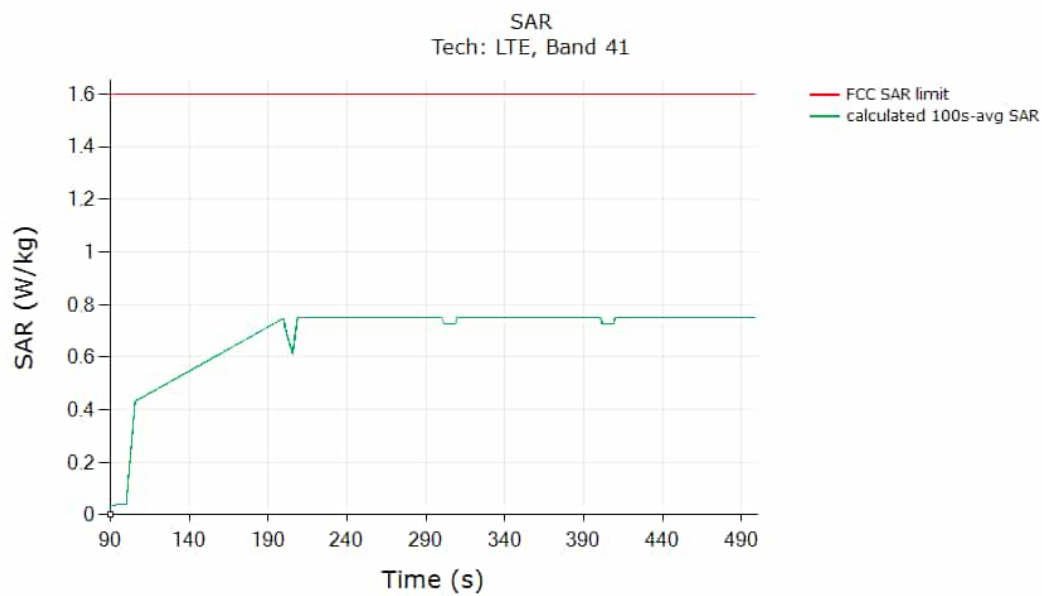
7.3.2 LTE Band 41 (test case 2 in Table 6-2)

Plot No. 2

Test result for test sequence 1:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR

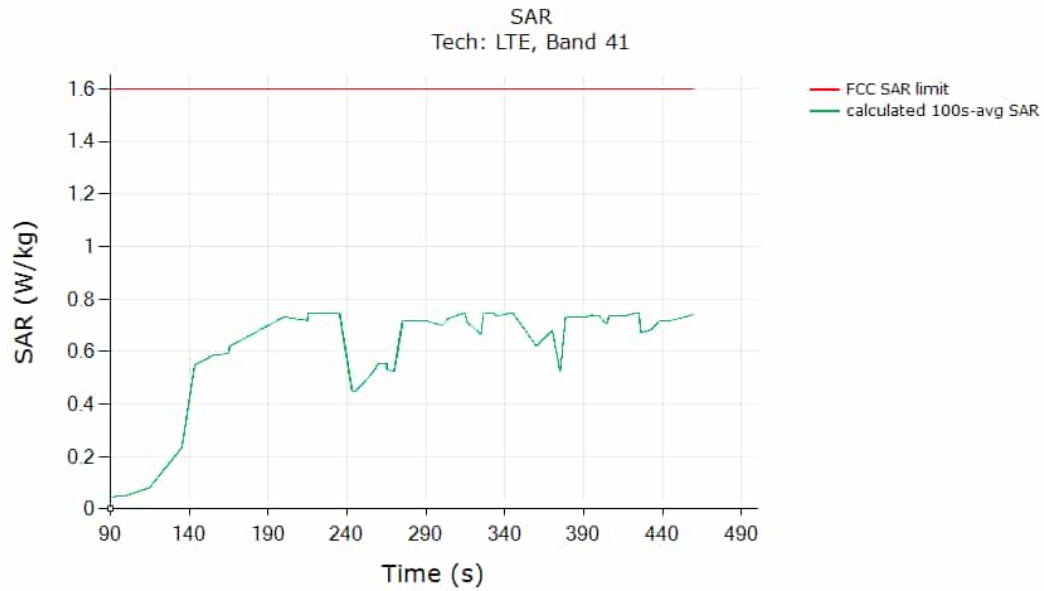
Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured P _{limit} [dBm]	Measured P _{max} [dBm]	Part 1 Worst Case Measured SAR at P _{limit} (W/kg)
LTE TDD	B41	C	0	2 636.5	1/0/20 MHz BW	11.02	20.66	0.758



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1gSAR (green curve)	0.750 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at P _{limit} (last column in Table 7-1).	

Test result for test sequence 2:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1.6gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1.6gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1gSAR (green curve)	0.748 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P</i> _{limit} (last column in Table 7-1).	

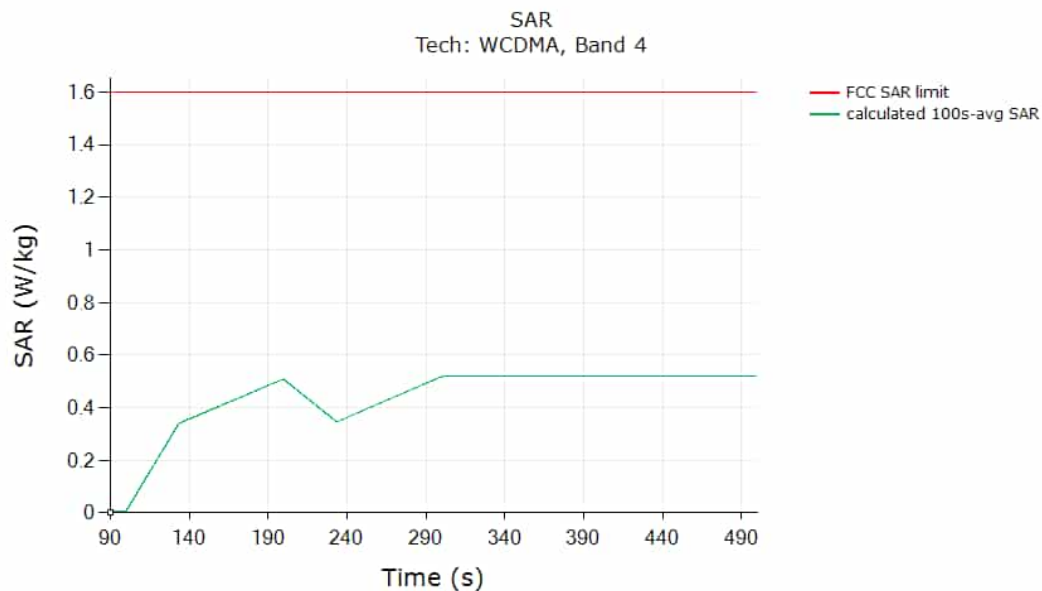
7.3.3 UMTS Band 4 (test case 3 in Table 6-2)

Plot No. 3

Test result for test sequence 1

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR

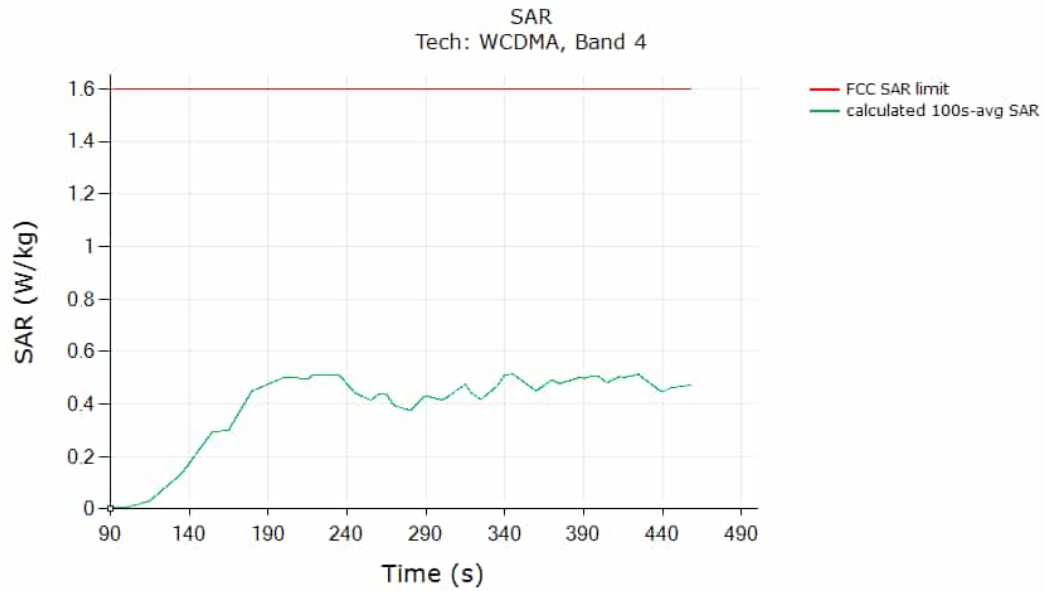
Tech	Band	Antenna	DSI	Frequency [MHz]	Mode	Measured <i>P</i> _{limit} [dBm]	Measured <i>P</i> _{max} [dBm]	Part 1 Worst Case Measured SAR at <i>P</i> _{limit} (W/kg)
UMTS	B4	A	0	1 732.6	RMC	20.42	23.36	0.506



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1gSAR (green curve)	0.519 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P</i> _{limit} (last column in Table 7-1).	

Test result for test sequence 2:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1gSAR (green curve)	0.514 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P</i> _{limit} (last column in Table 7-1).	

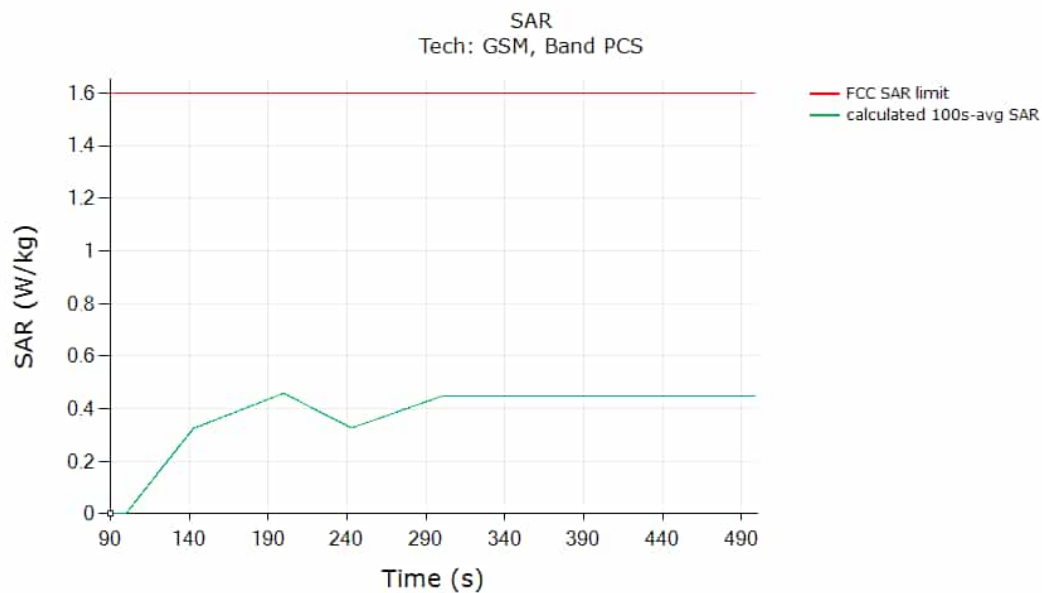
7.3.4 GSM/GPRS/EDGE/1900 (test case 4 in Table 6-2)

Plot No. 4

Test result for test sequence 1

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR

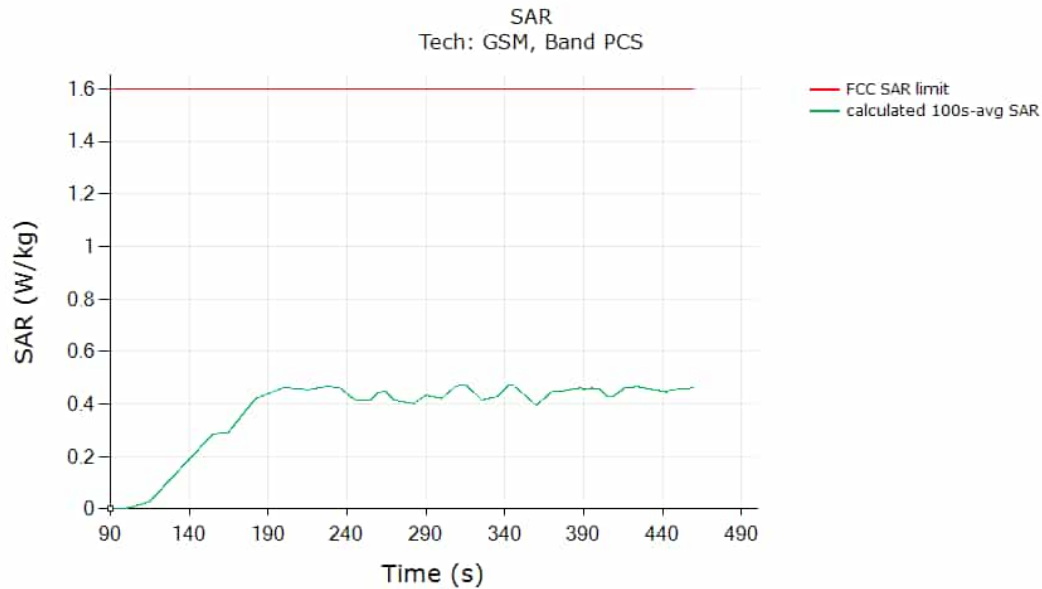
Tech	Band	Antenna	DSI	Frequency [MHz]	Mode	Measured <i>P</i> _{limit} [dBm]	Measured <i>P</i> _{max} [dBm]	Part 1 Worst Case Measured SAR at <i>P</i> _{limit} (W/kg)
GPRS	1900	A	0	1 880	GMSK	20.18	22.61	0.433



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1gSAR (green curve)	0.459 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P</i> _{limit} (last column in Table 7-1).	

Test result for test sequence 2:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1gSAR (green curve)	0.474 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P</i> _{limit} (last column in Table 7-1).	

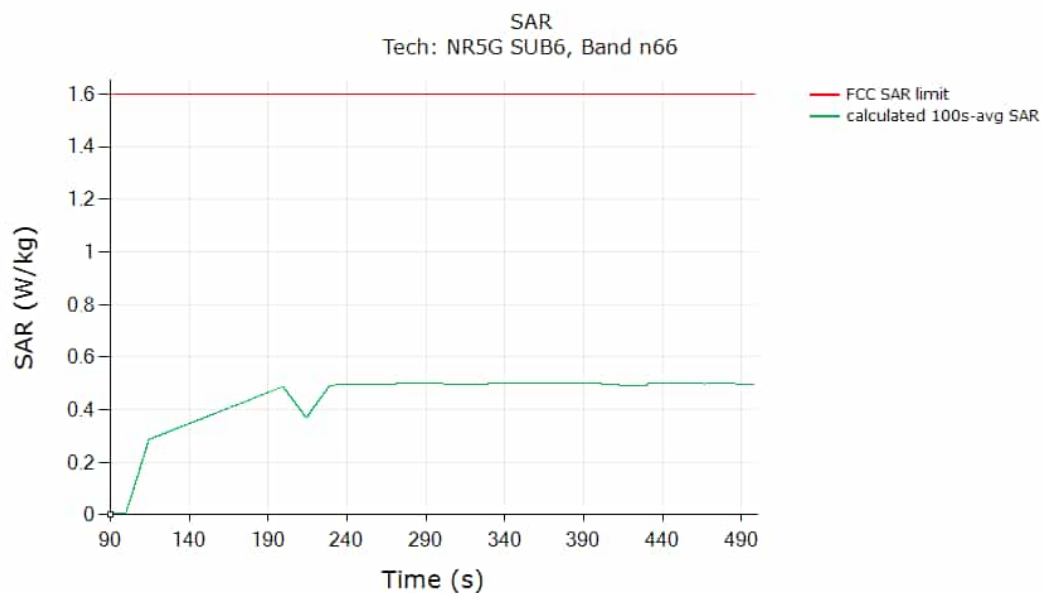
7.3.5 Sub6 NR n66 (test case 5 in Table 6-2)

Plot No. 5

Test result for test sequence 1

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR:

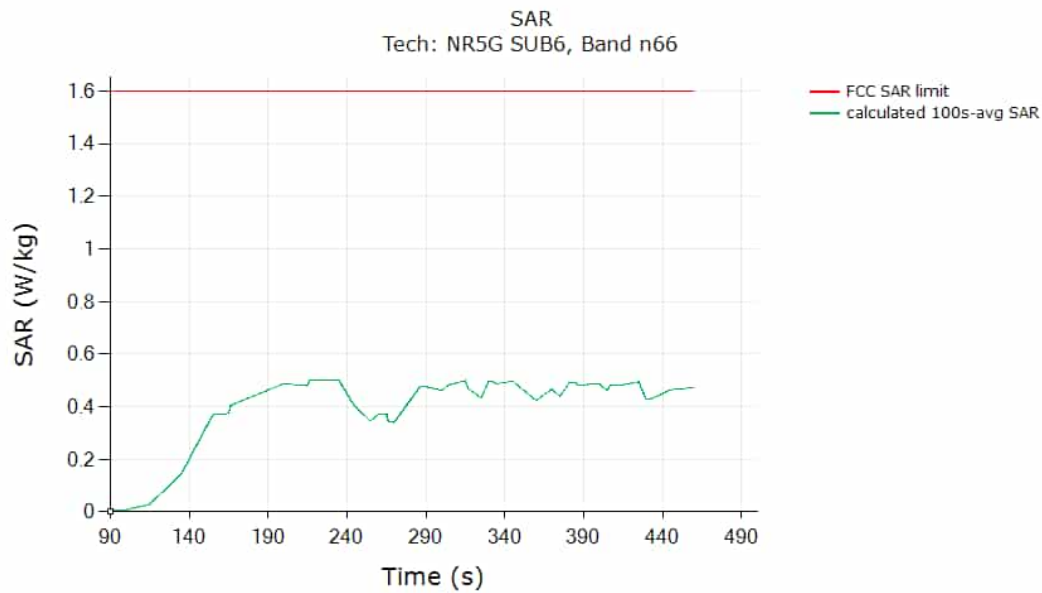
Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured <i>P</i> _{limit} [dBm]	Measured <i>P</i> _{max} [dBm]	Part 1 Worst Case Measured SAR at <i>P</i> _{limit} (W/kg)
Sub6 NR	N66	F	1	1 745	1/214/40 MHz BW	18.23	24.22	0.479



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1g SAR (green curve)	0.501 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P</i> _{limit} (last column in Table 7-1).	

Test result for test sequence 2:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR:



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 1gSAR (green curve)	0.501 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>Plimit</i> (last column in Table 7-1).	

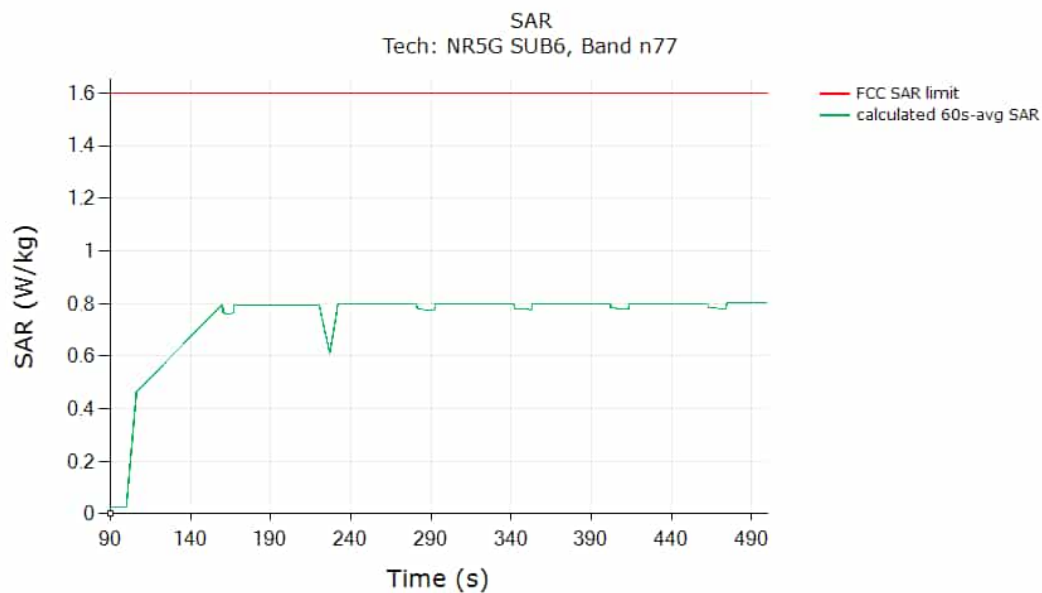
7.3.6 Sub6 NR n77 (test case 6 in Table 6-2)

Plot No. 6

Test result for test sequence 1

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR:

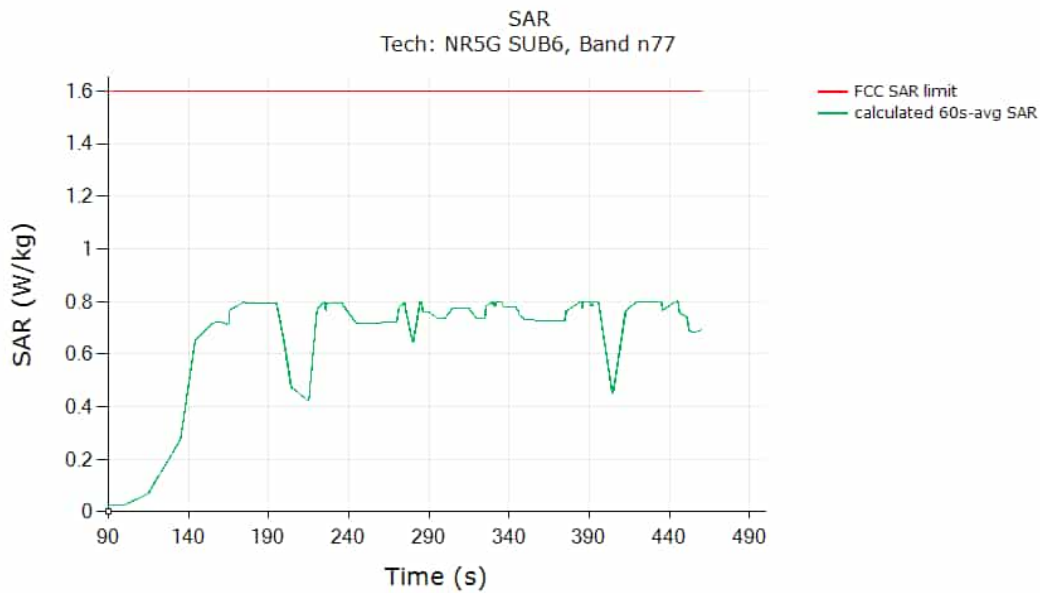
Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured <i>P</i> _{limit} [dBm]	Measured <i>P</i> _{max} [dBm]	Part 1 Worst Case Measured SAR at <i>P</i> _{limit} (W/kg)
NR TDD	n77	G	0	3 500.1	1/137/100 MHz BW	13.59	22.58	0.657



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 60s-time averaged 1g SAR (green curve)	0.801 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P</i> _{limit} (last column in Table 7-1).	

Test result for test sequence 2:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR:



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 60s-time averaged 1gSAR (green curve)	0.801 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P_{limit}</i> (last column in Table 7-1).	

7.4 Change in Call Test results (test case 7 in Table 6-2)

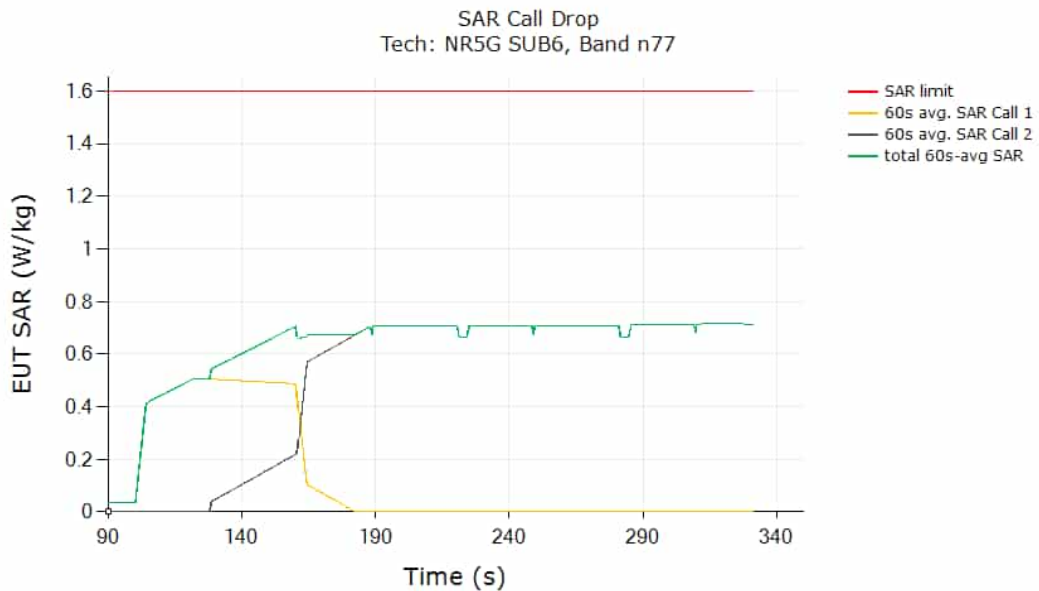
This test was measured with NR n77, DSI=0 (Free), and with callbox requesting maximum power. The call drop was manually performed when the EUT is transmitting at *P_{reserve}* level as shown in the plot below. The measurement setup is shown in Figure 8-1(a). The detailed test procedure is described in Section 5.3.2.

Plot No. 7

Call drop test result:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR:

Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured <i>P_{limit}</i> [dBm]	Measured <i>P_{max}</i> [dBm]	Part 1 Worst Case Measured SAR at <i>P_{limit}</i> (W/kg)
NR TDD	n77	G	0	3 500.1	1/137/100 MHz BW	13.59	22.58	0.657



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 60s-time averaged 1gSAR (green curve)	0.714 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at <i>P_{limit}</i> (last column in Table 7-1).	

The test result validated the continuity of power limiting in call change scenario.

7.5 Change in technology/band test results (test case 8 in Table 6-2)

This test was conducted with callbox requesting maximum power, and with technology switch from LTE B2, DSI = 0 (Free) to UMTS B4, DSI = 0 (Free). Following procedure detailed in Section 5.3.3, and using the measurement setup shown in Figure 8-1(b).

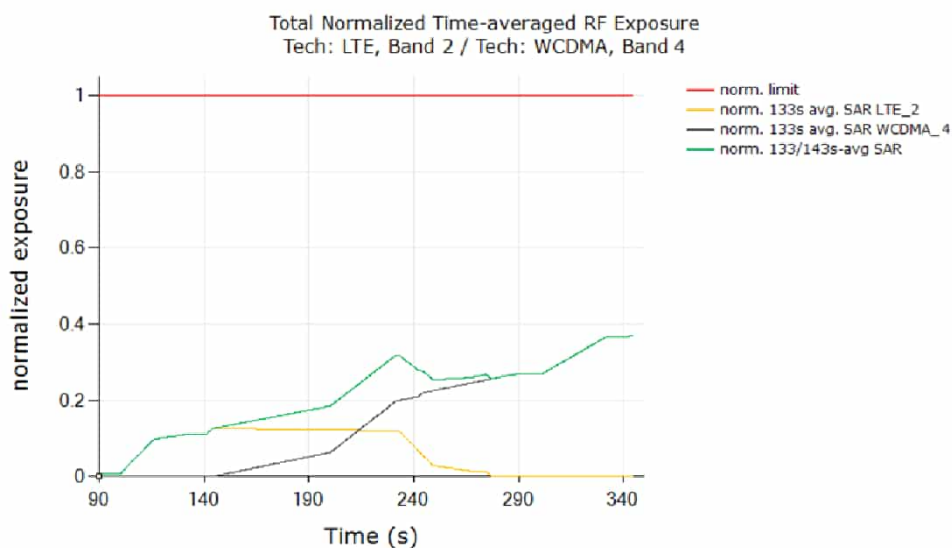
Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured <i>P</i> _{limit} [dBm]	Measured <i>P</i> _{max} [dBm]	Part 1 Worst Case Measured SAR at <i>P</i> _{limit} (W/kg)
LTE	B2	A	0	1 860	1/99/20 MHz BW	17.71	23.52	0.335
UMTS	B4	A	0	1 732.6	-	20.42	23.36	0.506

the technology/band switch was performed when the EUT is transmitting at *P*_{reserve} level as shown in the plot below

Plot No. 8

Test result for change in technology/band:

All the time-averaged conducted Tx power measurement results were converted into time-averaged normalized SAR values using Equation (6a), (6b) and (6c), and plotted below to demonstrate that the time-averaged normalized SAR versus time does not exceed the normalized FCC limit of 1.0:



FCC normalized SAR limit	1.0
Max 100s-time averaged normalized SAR(green curve)	0.370
Validated:	

The test result validated the continuity of power limiting in technology/band switch scenario.

7.6 Change in DSI test results (test case 9 in Table 6-2)

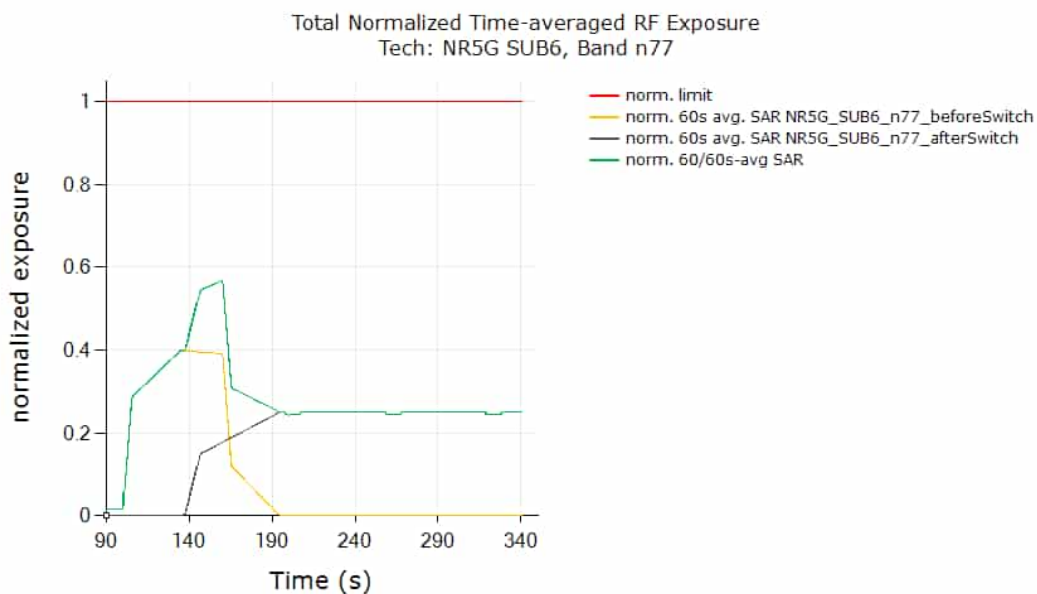
This test was conducted with callbox requesting maximum power, and with DSI switch from NR n77 DSI = 0 (Free), Plimit = 14.0 dBm to DSI = 1(RCV), Plimit = 16.0 dBm. Following procedure detailed in Section 5.3.5 using the measurement setup shown in Figure 8-1(a) and (c), the DSI switch was performed when the EUT is transmitting at Preserve level as shown in the plot below.

Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured Plimit [dBm]	Measured Pmax [dBm]	Part 1 Worst Case Measured SAR at Plimit (W/kg)
Sub6 NR	n77	G	0	3 500.01	1/137/100 MHz BW	13.59	22.58	0.657
	n77	G	1	3 500.01	1/1/100 MHz BW	15.61	22.58	0.331

Plot No. 9

Test result for change in DSI:

All the time-averaged conducted Tx power measurement results were converted into time-averaged normalized SAR values using Equation (6a), (6b) and (6c), and plotted below to demonstrate that the time-averaged normalized SAR versus time does not exceed the normalized FCC limit of 1.0:



FCC normalized SAR limit	1.0
Max 100s-time averaged normalized SAR(green curve)	0.569
Validated:	

7.8 Change in Antenna Switch test results (test case 10 in Table 6-2)

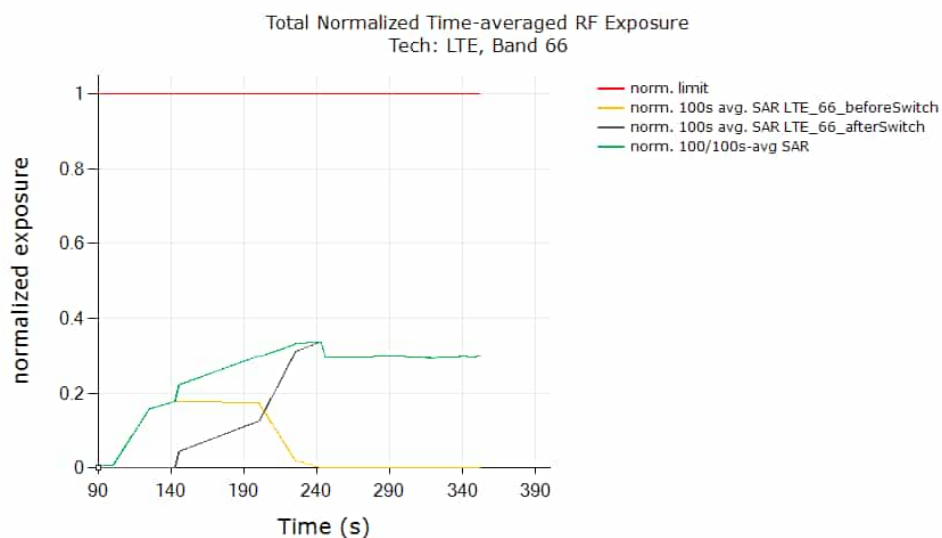
This test was conducted with callbox requesting maximum power, and with Antenna switch from LTE B66, DSI = 0 (Free), Plimit = 20.0 dBm to LTE B41 DSI = 0 (Free), Plimit = 11.5 dBm. Following procedure detailed in Section 5.3.4, and using the measurement setup shown in Table 7-1(b) the Antenna switch was performed when the EUT is transmitting at $P_{reserve}$ level as shown in the plot below.

Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured P_{limit} [dBm]	Measured P_{max} [dBm]	Part 1 Worst Case Measured SAR at P_{limit} (W/kg)
LTE	B66	F	0	1 745	1/0/20 MHz BW	19.05	23.20	0.376
	B41	C	0	2 636.5	1/0/20 MHz BW	11.02	20.66	0.758

Plot No. 10

Test result for change in Antenna Switch:

All the time-averaged conducted Tx power measurement results were converted into time- averaged normalized SAR values using Equation (6a), (6b) and (6c), and plotted below to demonstrate that the time- averaged normalized SAR versus time does not exceed the normalized FCC limit of 1.0:



FCC normalized SAR limit	1.0
Max 100s-time averaged normalized SAR(green curve)	0.338
Validated:	

The test result validated the continuity of power limiting in technology/band switch scenario.

7.9 Change in Time window switch test results (test case 11 in Table 6-2)

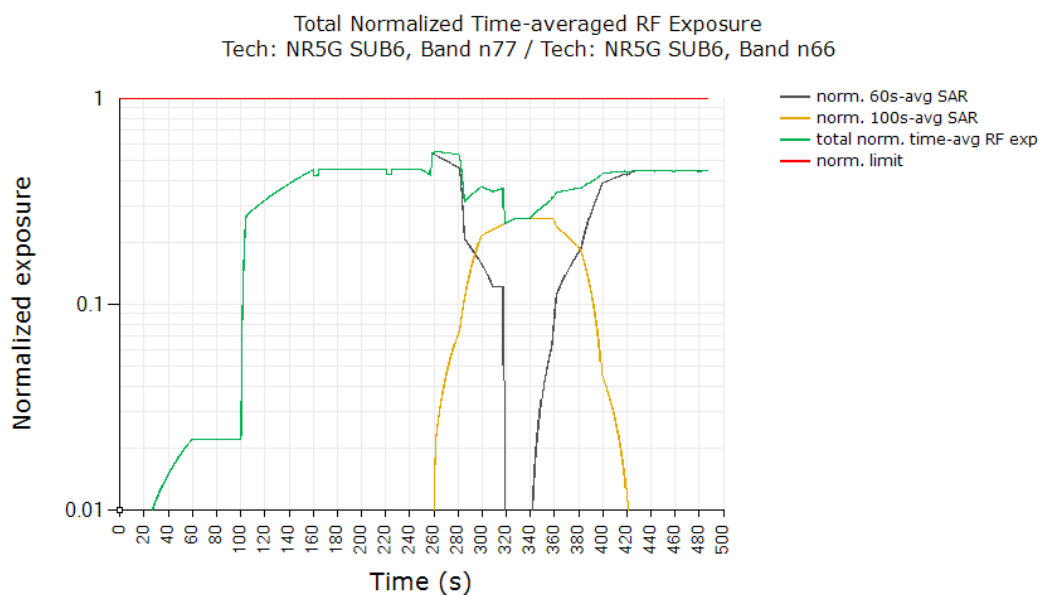
This test was conducted with callbox requesting maximum power, and with antenna switch between NR n77(60s), DSI = 0(Free) and NR n66(100s), DSI = 0(Free).

Tech	Band	Antenna	Time window (sec)	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured <i>P</i> _{limit} [dBm]	Measured <i>P</i> _{max} [dBm]	Part 1 Worst Case Measured SAR at <i>P</i> _{limit} (W/kg)
NR	n66	F	100	1 745	1/214/40 MHz BW	20.21	24.22	0.476
	n77	G	60	3 500.01	1/137/100 MHz BW	13.59	22.58	0.657

Following procedure detailed in Section 5.3.6, and using the measurement setup shown in Table 7-1(b) the tech/band/antenna switch was performed when the EUT is transmitting at *Preserve* level.

7.9.1 Test case 1 : transition from NR n77 to NR n66 (i.e 60s to 100s) then back to NR n77

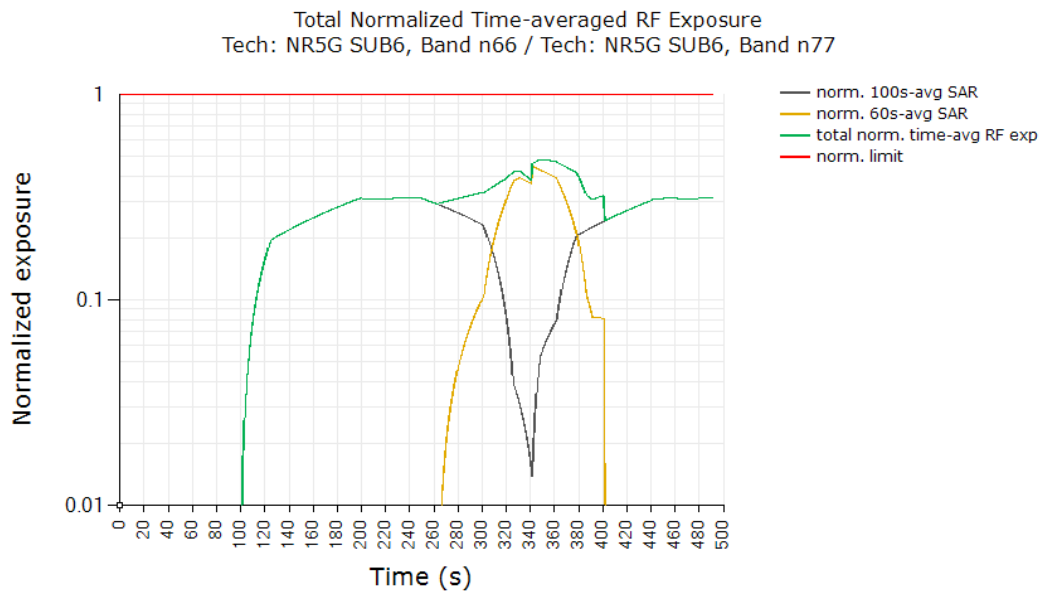
Plot No.11



FCC normalized total exposure limit	1.0
Max Norm. Total time-avg. SAR (green curve) (green curve)	0.553
Validated:	

7.9.2 Test case 2 : transition from NR n66 to NR n77 (i.e 100s to 60s) then back to NR n66

Plot No.12



FCC normalized total exposure limit	1.0
Max Norm. Total time-avg. SAR (green curve) (green curve)	0.482
Validated:	

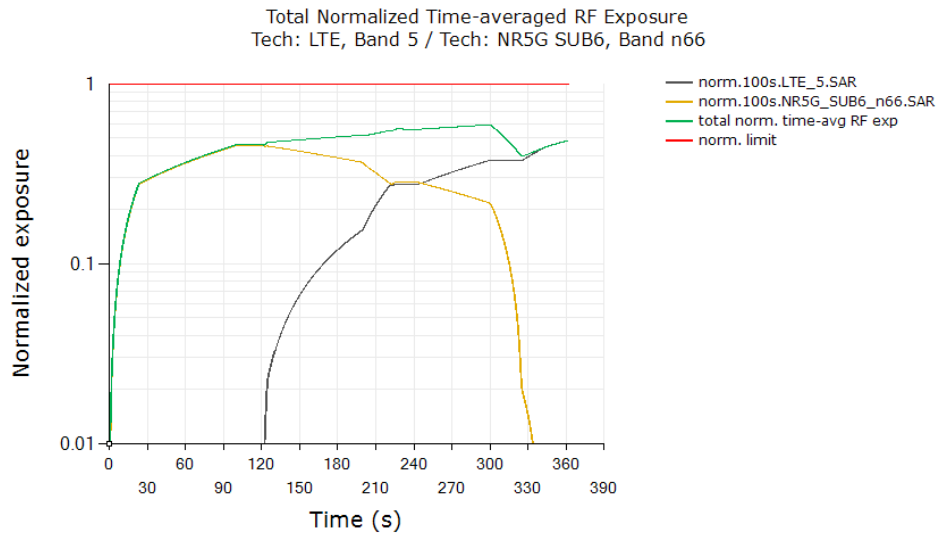
7.10 Switch in SAR exposure test results (test case 12 in Table 6-2)

This test was conducted with callbox requesting maximum power, and with the EUT in LTE B5 + Sub6 NR Band n66 call. Here, LTE B5, DSI = 0(Free)(100s window, P_{limit} = 24.0 dBm, P_{max} = 24.5 dBm, measured P_{limit} = 23.68 dBm), and Sub6 NR Band n66, DSI = 0 (Free)(100s window, P_{limit} = 20.0 dBm, EUT's average P_{max} = 24.0 dBm, measured P_{limit} = 20.54 dBm. Following procedure detailed in Section 5.3.7 and Appendix B.2, and using the measurement setup shown in Table 7-1(c) since LTE and Sub6 NR are sharing the same antenna port. The SAR exposure switch measurement is performed with the EUT in various SAR exposure scenarios, i.e., in SARsub6NR only scenario (t =10s ~125s), SARsub6NR + SARLTE scenario (t =125s ~ 245s) and SARLTE only scenario (t >245s).

Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured P_{limit} [dBm]	Measured P_{max} [dBm]	Part 1 Worst Case Measured SAR at P_{limit} (W/kg)
LTE	B5	A	0	836.5	1/0/10 MHz BW	23.68	24.18	0.740
Sub6 NR	n66	A	0	1 745	1/108/40 MHz BW	20.54	24.02	0.699

Plot No.13

All the conducted Tx power measurement results were converted into time-averaged normalized SAR values using Equation (7a), (7b) and (7c), and plotted below to demonstrate that the time-averaged normalized SAR versus time does not exceed the FCC limit of 1 unit. Equation (7a) is used to convert the LTE Tx power of device to obtain 100s-averaged normalized SAR in LTE as shown in black curve. Similarly, equation (7b) is used to obtain 100s-averaged normalized SAR in Sub6 NR as shown in orange curve. Equation (7c) is used to obtain total time-averaged normalized SAR as shown in green curve (i.e., sum of black and orange curves).



FCC normalized total exposure limit	1.0
Max Norm. Total time-avg. SAR (green curve) (green curve)	0.593
Validated:	

Plot Notes:

Device starts predominantly in Sub6 NR SAR exposure scenario between 5s and 125s, and in LTE SAR + Sub6 NR SAR exposure scenario between 125s and 245s, and in predominantly in LTE SAR exposure scenario after t=245s. Here, Smart Transmit allocates a maximum of 100% of exposure margin (based on 3.0 dB reserve margin setting) for Sub6 NR. This corresponds to a normalized 1gSAR exposure value = $100\% \cdot 0.699 \text{ W/kg measured SAR at Sub6 NR } P_{limit} / 1.6 \text{ W/kg limit} = 0.457 \pm 1\text{dB}$ device related uncertainty (see orange curve between 5s~125s). For predominantly LTE SAR exposure scenario, maximum normalized 1gSAR exposure should correspond to 100% exposure margin = $0.740 \text{ W/kg measured SAR at LTE } P_{limit} / 1.6 \text{ W/kg limit} = 0.485 \pm 1\text{dB}$ device related uncertainty (see black curve after t=245s).

Additionally, in SAR exposure switch test, at all times the total time-averaged normalized RF exposure (green curve) should not exceed normalized SAR_design_target + 1dB device uncertainty. In this test, with a maximum normalized SAR of 0.593 being $\leq 0.794 (= 1/1.6 + 1\text{dB device uncertainty})$, the above test result validated the continuity of power limiting in SAR exposure switch scenario.

7.11 Switch in SAR exposure test results (test case 13 in Table 6-2)

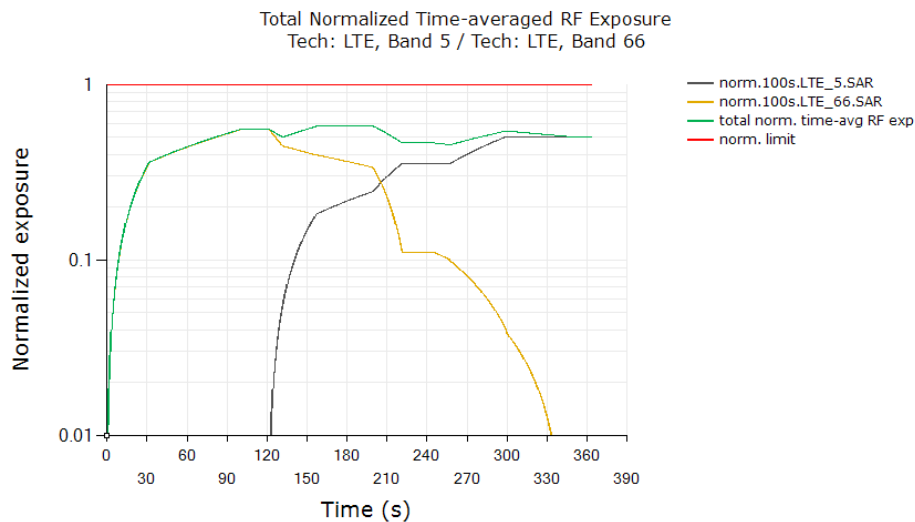
This test was conducted with callbox requesting maximum power, and with the EUT in LTE B5(PCC) + LTE B66(SCC) call. Here, LTE B5, DSI = 0(Free)(100s window, P_{limit} = 24.0 dBm, P_{max} = 24.5 dBm, measured P_{limit} = 23.68 dBm), and LTE B66, DSI = 0 (Free)(100s window, P_{limit} = 20.0 dBm, EUT's average P_{max} = 24.0 dBm, measured P_{limit} = 19.90 dBm.

Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured P_{limit} [dBm]	Measured P_{max} [dBm]	Part 1 Worst Case Measured SAR at P_{limit} (W/kg)
LTE	B5	A	0	836.5	1/0/10 MHz BW	23.68	24.18	0.740
LTE	B66	A	0	1 720	1/49/20 MHz BW	19.90	23.99	0.736

Following procedure detailed in Section 5.3.7 and Appendix B.2, and using the measurement setup shown in Table 7-1(c) since LTE_{PCC} and LTE_{SCC} are sharing the same antenna port. The SAR exposure switch measurement is performed with the EUT in various SAR exposure scenarios, i.e., in SAR_{SCC} only scenario (t = 10s ~ 125s), SAR_{LTE_{SCC}} + SAR_{LTE_{PCC}} scenario (t = 125s ~ 245s) and SAR_{LTE_{PCC}} only scenario (t > 245s).

Plot No.14

All the conducted Tx power measurement results were converted into time-averaged normalized SAR values using Equation (7a), (7b) and (7c), and plotted below to demonstrate that the time-averaged normalized SAR versus time does not exceed the FCC limit of 1 unit. Equation (7a) is used to convert the LTE Tx power of device to obtain 100s-averaged normalized SAR in LTE_{PCC} as shown in black curve. Similarly, equation (7b) is used to obtain 100s-averaged normalized SAR in LTE_{SCC} as shown in orange curve. Equation (7c) is used to obtain total time-averaged normalized SAR as shown in green curve (i.e., sum of black and orange curves).



FCC normalized total exposure limit	1.0
Max Norm. Total time-avg. SAR (green curve) (green curve)	0.583
Validated:	

Plot Notes:

Device starts predominantly in LTE SCC SAR exposure scenario between 5s and 125s, and in LTE PCC SAR + LTE SCC SAR exposure scenario between 125s and 245s, and in predominantly in LTE PCC SAR exposure scenario after t=245s. Here, Smart Transmit allocates a maximum of 100% of exposure margin (based on 3.0 dB reserve margin setting) for LTE SCC. This corresponds to a normalized 1gSAR exposure value = $100\% \cdot 0.736 \text{ W/kg measured SAR at LTE SCC } P_{\text{limit}} / 1.6 \text{ W/kg limit} = 0.557 \pm 1\text{dB device related uncertainty}$ (see orange curve between 5s~125s). For predominantly LTE PCC SAR exposure scenario, maximum normalized 1gSAR exposure should correspond to 100% exposure margin = $0.740 \text{ W/kg measured SAR at LTE PCC } P_{\text{limit}} / 1.6 \text{ W/kg limit} = 0.506 \pm 1\text{dB device related uncertainty}$ (see black curve after t =245s).

Additionally, in SAR exposure switch test, at all times the total time-averaged normalized RF exposure (green curve) should not exceed normalized SAR_design_target + 1dB device uncertainty. In this test, with a maximum normalized SAR of 0.583 being $\leq 0.794 (= 1/1.6 + 1\text{dB device uncertainty})$, the above test result validated the continuity of power limiting in SAR exposure switch scenario.

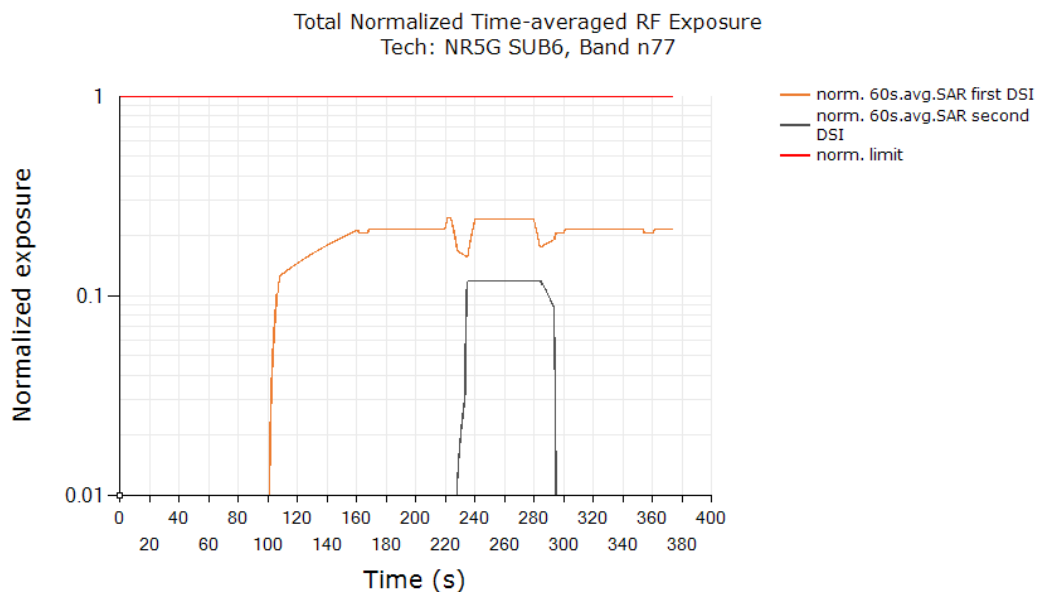
7.12 Exposure Category Switch (test case 14,15 in Table 6-2)

This test was conducted with callbox requesting maximum power, and with switch between NR n77, DSI=1(RCV on/ Head Exposure) and NR n77, DSI=0(Free/ Body Exposure). Following procedure detailed in Sec 5.3.8 and using the measurement setup shown in Table 7-1(a), the exposure category switch was performed when the EUT is transmitting at Preserve level.

Tech	Band	Antenna	DSI	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Measured P _{limit} [dBm]	Measured P _{max} [dBm]	Part 1 Worst Case Measured SAR at P _{limit} (W/kg)
Sub6 NR	n77	A	1	3 500.01	1/1/100 MHz BW	15.61	22.58	0.331
	n77	A	0	3 500.01	1/137/100 MHz BW	13.59	22.58	0.657

Plot 15

Maximum power is requested by callbox for the entire duration of the test, time-averaged exposure in head DSI gradually increases until t~149s where the device is switched from head exposure DSI(first DSI, orange curve) to non-head exposure DSI(second DSI, black curve) as evident from increase in exposure of black curve and no change in orange curve between t~149s and t~161s. At t161s~, device is switched back from non-head exposure to head exposure as evident from increase in exposure of orange curve and no change in black curve. In this test, the time-averaged normalized RF exposure in head exposure DSI(orange curve) did not exceed normalized limit of 1.0 at all times, and is less than normalized SAR 0.245 being $\leq 0.794 (=1.0/1.6 + 1\text{dB device uncertainty})$, validating the exposure continuity when switching between head exposure and non-head exposure categories.

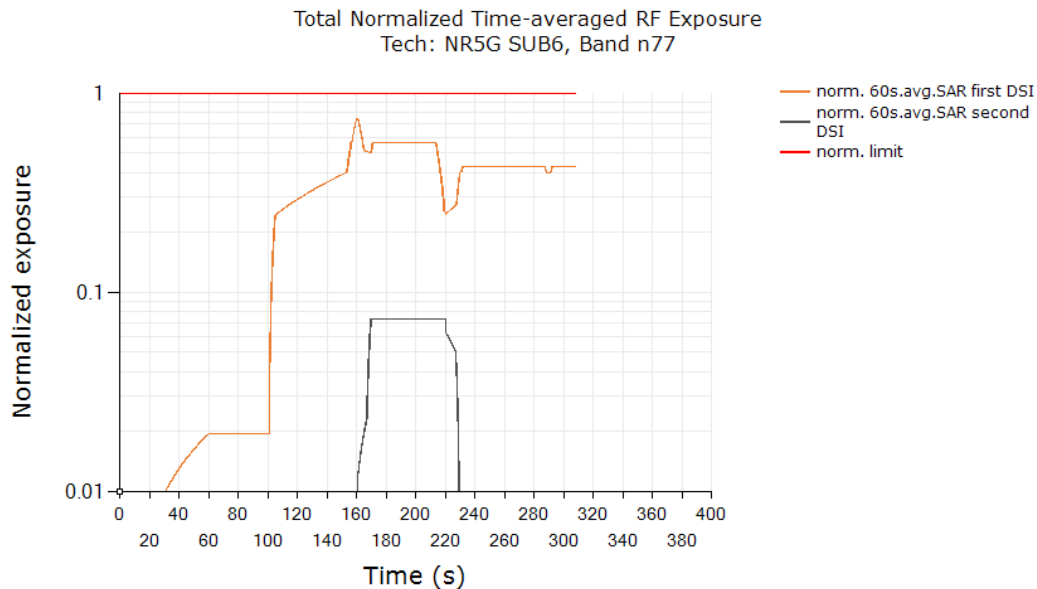


FCC normalized total exposure limit	1.0
Max 100s-time averaged normalized SAR (first DSI, orange curve)	0.245
Validated:	

This test was conducted with callbox requesting maximum power, and with switch between NR n41, DSI=0(Free/ Body Exposure) and NR n41, DSI=1(RCV on/ Head Exposure). Following procedure detailed in Sec 5.3.8 and using the measurement setup shown in Table 7-1(a), the exposure category switch was performed when the EUT is transmitting at Preserve level.

Plot 16

Maximum power is requested by callbox for the entire duration of the test, time-averaged exposure in non-head DSI gradually increases until t~149s where the device is switched from non-head exposure DSI(first DSI, orange curve) to head exposure DSI(second DSI, black curve) as evident from increase in exposure of black curve and no change in orange curve between t~149s and t~158s. At t 158s~, device is switched back from head exposure to non-head exposure as evident from increase in exposure of orange curve and no change in black curve. In this test, the time-averaged normalized RF exposure in head exposure DSI(orange curve) did not exceed normalized limit of 1.0 at all times, and is less than normalized SAR being $0.744 \leq 0.794 (=1.0/1.6 + 1\text{dB device uncertainty})$, validating the exposure continuity when switching between non-head exposure and head exposure categories.



FCC normalized total exposure limit	1.0
Max 100s-time averaged normalized SAR (first DSI, orange curve)	0.744
Validated:	

8. Equipment List

Manufacturer	Type / Model	S/N	Calib. Date	Calib.Interval	Calib.Due
R&S	Wireless Communication Test Set/ CMW500	127521	04/07/2026	Annual	04/07/2027
Anritsu	Radio communication test station/MT8000A	6262036812	11/24/2025	Annual	11/24/2026
R&S	Power Sensor/NRP8S	114588	01/16/2026	Annual	01/16/2027
R&S	Power Sensor/NRP8S	114589	01/16/2026	Annual	01/16/2027
NARDA	Directional Coupler / 4216-10	01490	11/19/2025	Annual	11/19/2026
Narda	Directional Coupler/4216-10	01653	06/25/2025	Annual	06/25/2026
RFcorea	2Way splitter	473841	12/01/2025	Annual	12/01/2026
Microlab	LP-Filter/LA-30N	-	10/21/2025	Annual	10/21/2026
Microlab	LP-Filter/LA-15N	10453	09/05/2025	Annual	09/05/2026
WEINWRIGHT INSTRUMENTS	High Pass Filter/WHKX12-935	95	02/02/2026	Annual	02/02/2027
WEINWRIGHT INSTRUMENTS	High Pass Filter/WHKX12-2805	61	02/02/2026	Annual	02/02/2027

9. Conclusion

Qualcomm Smart Transmit feature employed in Samsung Mobile Phone (FCC ID: A3LSMA276B) has been validated through the conducted measurement (as demonstrated in Chapters 7)

As demonstrated in this report, the power limiting enforcement is effective and the total normalized time-averaged RF exposure does not exceed 1.0 for all the transmission scenarios described in Section 4.

Therefore, the EUT complies with FCC RF exposure requirement.

Appendix A: Test Sequences

1. Test sequence is generated based on below parameters of the EUT:

- Measured maximum power (P_{max})
- Measured Tx_power_at_SAR_design_target (P_{limit})
- Reserve_power_margin (dB)

$$P_{reserve}(\text{dBm}) = \text{measured } P_{limit}(\text{dBm}) - \text{Reserve_power_margin (dB)}$$

For EUT enabled with Smart Transmit EFS version 18, } 2G and 3G WWAN technologies:

$$\text{Reserve_power_margin (dB)} = \text{reserve_power_margin_db_2g_3g_wwan }$$

4G and 5G WWAN technologies: Reserve_power_margin (dB) =

$$-10 \cdot \log_{10}(\text{total_min_exp_budget_linear_4g_5g_wwan}) \text{ for 4G and 5G technologies}$$

- For EUT enabled with Smart Transmit EFS version 19 (or higher),

If only WWAN technology is managed under Smart Transmit: Reserve_power_margin (dB)

$$= -10 \cdot \log_{10}(\text{TOTAL_MIN_RES_RATIO}) }$$

FCC SAR_time_window (100s for $f < 3\text{GHz}$, 60s for $3\text{GHz} < f \leq 6\text{GHz}$ and 30s for $6\text{GHz} < f \leq 10\text{GHz}$)

2. Test Sequence 1 Waveform:

Based on the parameters above, the Test Sequence 1 is generated with one transition between high and low Tx powers. Here, high power = P_{max} ; low power = $P_{max}/2$, and the transition occurs after 80 seconds at high power P_{max} . As long as the power enforcement is taking into effective during one 100s/60s time window, the validation test with this defined test sequence 1 is valid, otherwise, select other radio configuration (band/DSI within the same technology group) having lower P_{limit} for this test. The Test sequence 1 waveform is shown below:

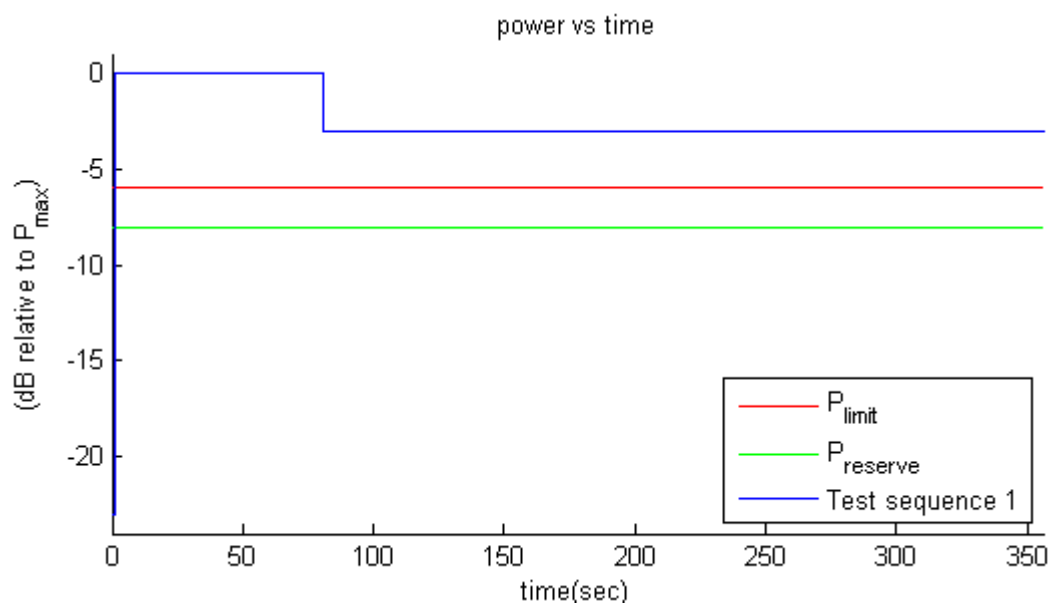


Figure 1 Test sequence 1 waveform

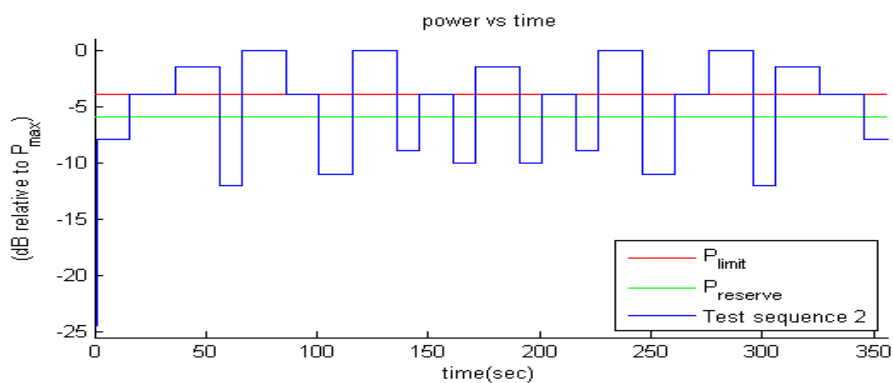
3. Test Sequence 2 Waveform:

Based on the parameters in A-1, the Test Sequence 2 is generated as described in Table A-1, which contains two 170 second-long sequences (yellow and green highlighted rows) that are mirrored around the center row of 20s, resulting in a total duration of 360 seconds:

Table -1 Test Sequence 2

Time duration (seconds)	dB relative to P_{limit} or $P_{reserve}$
15	$P_{reserve} - 2$
20	P_{limit}
20	$(P_{limit} + P_{max})/2$ averaged in mW and rounded to nearest 0.1 dB step
10	$P_{reserve} - 6$
20	P_{max}
15	P_{limit}
15	$P_{reserve} - 5$
20	P_{max}
10	$P_{reserve} - 3$
15	P_{limit}
10	$P_{reserve} - 4$
20	$(P_{limit} + P_{max})/2$ averaged in mW and rounded to nearest 0.1 dB step
10	$P_{reserve} - 4$
15	P_{limit}
10	$P_{reserve} - 3$
20	P_{max}
15	$P_{reserve} - 5$
15	P_{limit}
20	P_{max}
10	$P_{reserve} - 6$
20	$(P_{limit} + P_{max})/2$ averaged in mW and rounded to nearest 0.1 dB step
20	P_{limit}
15	$P_{reserve} - 2$

The Test Sequence 2 waveform is shown in Figure A-2



Appendix B: Test Procedures for sub6 NR + LTE Radio

Appendix B provides the test procedures for validating Qualcomm Smart Transmit feature for LTE + Sub6 NR non-standalone (NSA) mode transmission scenario, where sub-6GHz LTE link acts as an anchor.

B.1 Time-varying Tx power test for sub6 NR in NSA mode

Follows Section 5.2.1 to select test configurations for time-varying test. This test is performed with two pre-defined test sequences (described in Section 5.1) applied to Sub6 NR (with LTE on all-down bits or low power for the entire test after establishing the LTE+Sub6 NR call with the callbox). Follow the test procedures described in Section 5.3.1 to demonstrate the effectiveness of power limiting enforcement and that the time averaged Tx power of Sub6 NR when converted into 1gSAR values does not exceed the regulatory limit at all times (see Eq. (1a) and (1b)). Sub6 NR response to test sequence1 and test sequence2 will be similar to other technologies (say, LTE), and are shown in Sections 5.3.7 and 5.3.8.

B.2 Switch in SAR exposure between LTE vs. Sub6 NR during transmission

This test is to demonstrate that Smart Transmit feature accurately accounts for switching in exposures among SAR for LTE radio only, SAR from both LTE radio and sub6 NR, and SAR from sub6 NR only scenarios, and ensures total time-averaged RF exposure compliance with FCC limit.

Test procedure:

1. Measure conducted Tx power corresponding to P_{limit} for LTE and sub6 NR in selected band. Test condition to measure conducted P_{limit} is:
 - Establish device in call with the callbox for LTE in desired band. Measure conducted Tx power corresponding to LTE P_{limit} with Smart Transmit enabled and *Reserve_power_margin* set to 0 dB, callbox set to request maximum power.
 - Repeat above step to measure conducted Tx power corresponding to Sub6 NR P_{limit} . If testing LTE+Sub6 NR in non-standalone mode, then establish LTE+Sub6 NR call with callbox and request all down bits for radio1 LTE. In this scenario, with callbox requesting maximum power from Sub6 NR, measured conducted Tx power corresponds to radio2 P_{limit} (as radio1 LTE is at all-down bits)
2. Set *Reserve_power_margin* to actual (intended) value with EUT setup for LTE + Sub6 NR call. First, establish LTE connection in all-up bits with the callbox, and then Sub6 NR connection is added with callbox requesting UE to transmit at maximum power in Sub6 NR. As soon as the Sub6 NR connection is established, request all-down bits on LTE link (otherwise, Sub6 NR will not have sufficient RF exposure margin to sustain the call with LTE in all-up bits). Continue LTE (all-down bits)+Sub6 NR transmission for more than one time-window duration to test predominantly Sub6 NR SAR exposure scenario (as SAR exposure is negligible from all-down bits in LTE). After at least one time-window, request LTE to go all-up bits to test LTE SAR and Sub6 NR SAR exposure scenario. After at least one more time-window, drop (or request all-down bits) Sub6 NR transmission to test predominantly LTE SAR exposure scenario. Continue the test for at least one more time-window. Record the conducted Tx powers for both LTE and Sub6 NR for the entire duration of this test.
3. Once the measurement is done, extract instantaneous Tx power versus time for both LTE and Sub6 NR links. Similar to technology/band switch test in Section 5.3.3, convert the conducted Tx power for both these radios into 1gSAR value (see Eq. (6a) and (6b)) using corresponding technology/band P_{limit} measured in Step 1, and then perform 100s running average to determine time-averaged 1gSAR versus time as illustrated in Figure 3-1. Note that here it is assumed both radios have Tx frequencies < 3GHz, otherwise, 60s running average should be performed for radios having Tx frequency between 3GHz and 6GHz.

4. Make one plot containing: (a) instantaneous Tx power versus time measured in Step 2.
 5. Make another plot containing: (a) instantaneous 1gSAR versus time determined in Step 3, (b) computed time-averaged 1gSAR versus time determined in Step 3, and (c) corresponding regulatory $1gSAR_{limit}$ of 1.6W/kg.
- The validation criteria is, at all times, the time-averaged 1gSAR versus time shall not exceed the regulatory $1gSAR_{limit}$ of 1.6W/kg.

Test procedure for Conducted Test Sequences:

For Sub6 NR TDD test cases, a modified procedure was used due to a limitation of the available test equipment.

1. Measure Pmax, measure Plimit and calculate Preserve (= measured Plimit in dBm = Reserve_power_margin in dB) and follow Section 5.1 to generate the test sequences for all the technologies and bands selected in Section 5.2.1. Both test sequence 1 and test sequence 2 are created based on generated Pmax_sequences of the DUT as described below. Test condition to measure Pmax and Plimit is:
 - 1) Measure Pmax_online_avg_dBm with Smart Transmit disabled and callbox set to request maximum power.
 - 2) Measure Plimit_online_avg_dBm with Smart Transmit enabled and Reserve_power_margin set to 0 dB, callbox set to request maximum power.
 - 3) Measure Plimit_ftm_dbm in FTM Mode at 25% Duty Cycle.
 - 4) Calculate the DutyCycle_dB = Plimit_ftm_dbm – Plimit_online_avg_dBm + 6 dB
 - 5) Calculate Pmax_seq = Pmax_online_avg_dBm + DutyCycle_dB
 - 6) Calculate Plimit_seq = Plimit_online_avg_dBm + DutyCycle_dB
2. Follow remaining steps in Section 5.3.1 to complete time-varying Tx test cases

For the SAR test cases, the procedure in Section 5.4 applies however the initial area scan as described in section 5.4 step 2) i) is performed with the device in FTM mode.

End.